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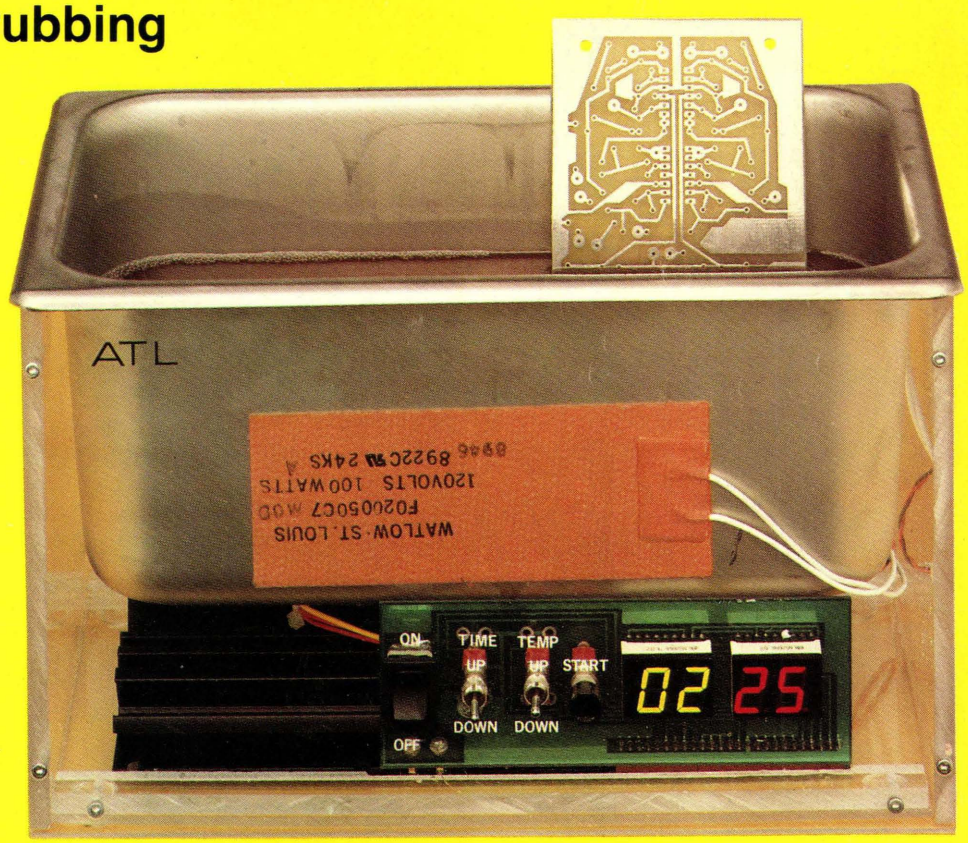

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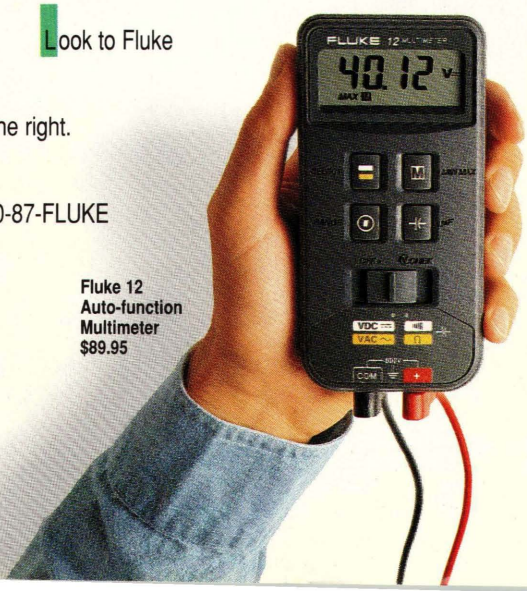

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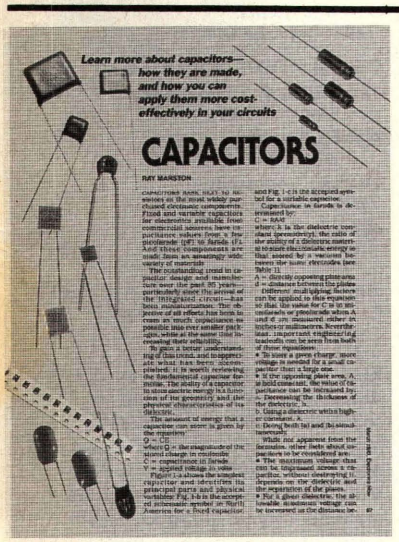
March 1993

Electronics NOW®

Vol. 64 No. 3

ON THE COVER

Delicate jewelry can be hard enough to clean. It's difficult to reach all the nooks and crannies using ordinary cleansers and cloths, and scrubbing with harsh abrasives can cause damage to fragile items. The same problems can be even worse when trying to clean tools, connectors, and parts. Ultrasonic cleaning has been a common solution in commercial and industrial applications, but factory-made ultrasonic cleaners are beyond the budgets for small companies and hobbyists. Now you can build your own ultrasonic cleaner. It uses non-toxic, non-flammable cleaning solutions—and a bubbling action created by piezoelectric transducers—to get your jewelry, car and bicycle parts, card-edge connectors, circuit boards, tools and coins spic and span. Turn to page 33 for all the details on this professional-quality project.



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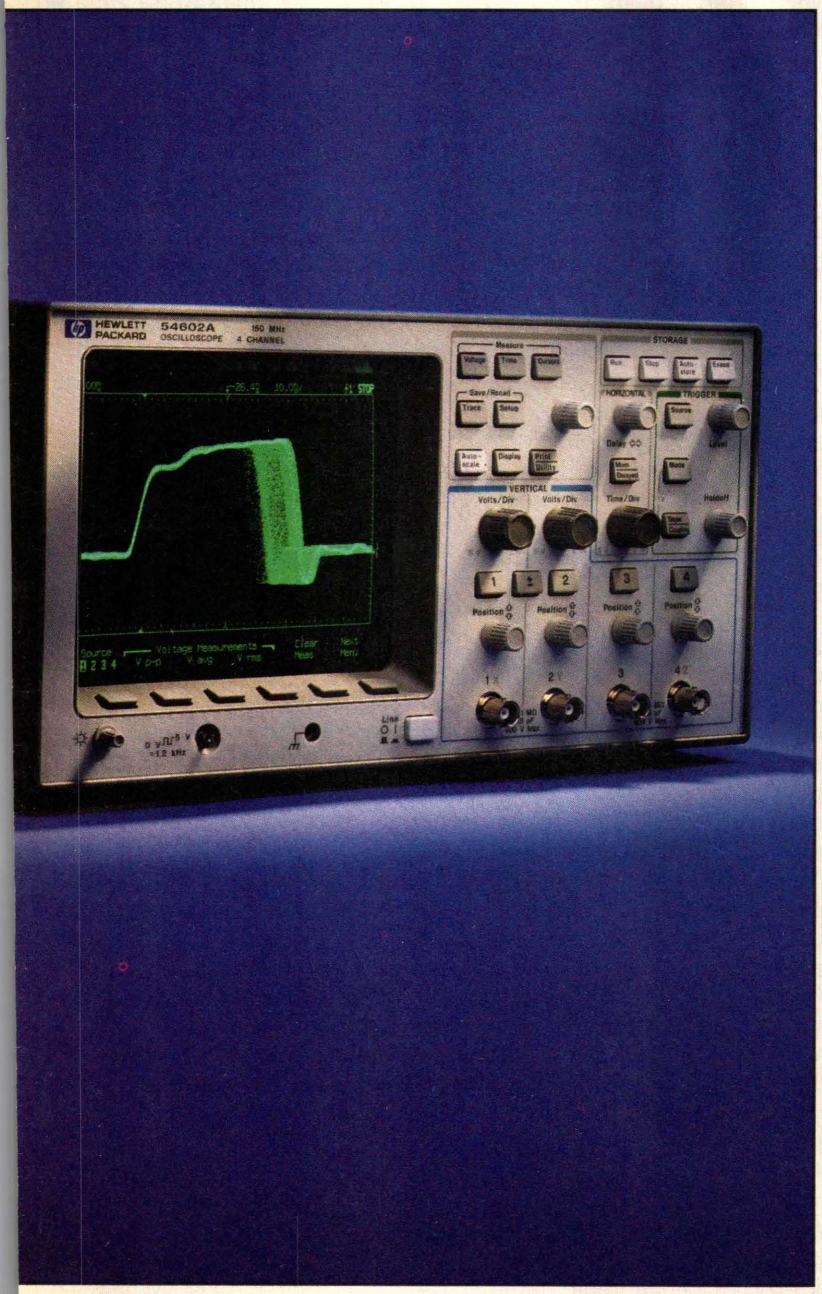

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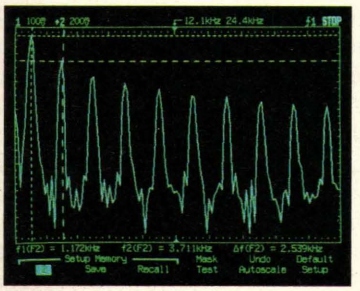

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WHAT'S NEWS

A review of the latest happenings in electronics.

Personal communicator explosion seen

Evidence from a number of sources points to the heating up of the handheld "personal communicator" market. As presently visualized, a personal communicator will be a box that includes the functions of a scratch pad, personal computer, electronic organizer, and, perhaps, a cellular telephone.

It is expected that the user will be able to write messages for storage on a screen with a pen, send those notes elsewhere, call up files of data and phone numbers, and even make phone calls—if the box has an integral cellular phone.

AT&T has been working hard to stake out a position in the communicator market. It has two axes to grind. It would like to sell its cellular communication services in that field, and it is seeking business for its own equipment manufacturing facilities. One way to assure that foothold is for AT&T to develop the standards that will be accepted by all other manufacturers and communications services providers.

So far, AT&T has forged alliances with several major electronics manufacturers, developed the "Hobbit" microprocessor chip for the units, and has stated its willingness to provide financial backing for suppliers and support software publishers.

Matsushita (Panasonic), NEC, and Toshiba have announced plans to build communicators based on AT&T's Hobbit microprocessor. AT&T is also negotiating a licensing agreement that would allow NEC to manufacture the Hobbit microprocessor. In addition, AT&T expects to sell its own brand of personal communicator, manufactured by Eo Computer, Inc. Mountain View, CA, a joint venture between AT&T, Matsushita, and Marubeni of Japan. It expects to sell the units through its national chain of AT&T Phone Centers.

AT&T is also working with Go Corp., whose PenPoint operating system is incorporated into the Eo-made products, to encourage the adoption of the operating system as an industry standard. Its plans include lining up more than a dozen software suppliers to write applications software that is compatible with the PenPoint software.

In another move, AT&T has designed the circuitry for a microminiature disk drive, and it is backing Sundisk, a company that makes a data-storage device for the communicators.

Apple has developed prototypes of a similar unit called the Newton, which it calls a "personal digital assistant" or PDA. Intel is reported to be working with VLSI Technology Inc. to develop a processor for the new units, and Motorola has signed investment and cross-technology agreements with both Apple and Sony.

Doubling digital video rate

The possibility of doubling the amount of digital information that can be transmitted on cable TV channels, without additional video compression, is now a reality. Zenith Electronics of Glenview, IL, has developed vestigial sideband (VSB) digital modulation and transmission technology that makes it possible.

Zenith's 16-level digital transmission system can send two digital HDTV signals on a single 6-MHz cable channel. That doubles the number of digitally compressed standard TV signals on a cable channel, and permits the delivery of as many as 23 movie channels or nine live-video channels. An alternative mix of one HDTV and several standard TV programs is also a possibility.

According to Zenith, radio transmission of digital TV signals results in lower quality TV received signals than cable. Programs transmitted to customers over cable are less likely to be distorted and suffer from interference. Signals in cables have better peak carrier-to-noise ratios and lower levels of interference.

Zenith took advantage of the greater noise-margin of cable transmissions to increase the information-carrying capacity, or data rate, of cable. To increase the amount of digital data delivered through a 6-MHz channel, a cable system must maintain a high signal-to-noise ratio, and must acquire and lock in the carrier, clock, and synchronization information. This is difficult to accomplish with the advanced digital modulation techniques such as 16- and 64-QAM (quadrature amplitude modulation).

By contrast, Zenith's VSB digital modulation and transmission technology, uses auxiliary signals for acquisition and synchronization. The pilot carrier, not feasible in QAM systems, and a data-segment synch signal are both independent of the data.

Zenith's 4-VSB technology obtains a data rate of 21.5 megabytes per second for its "Digital Spectrum Compatible" HDTV (DSC-HDTV) system. The company's newly developed, 16-VSB approach, an extension of the 4-VSB system, yields twice the channel data rate, or 43 megabits per second, with no increase in data compression requirements.

The 16-VSB system obtains signal acquisition even when ghosts and impedance mismatches are present. The system has simple analog-to-digital conversion needs, and it does not requires the more complex adaptive equalizer of the QAM systems. Therefore, 16-VBS is said to offer cost-effective, noise-free TV pictures and digital audio. Moreover, it is said to be compatible with existing computer, telephone, and other digital communications systems. Ω

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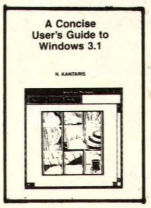

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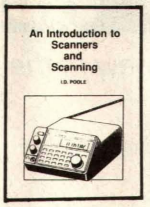

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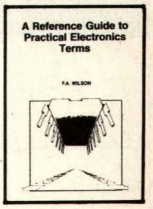

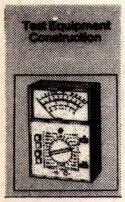

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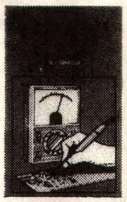

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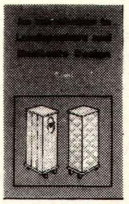

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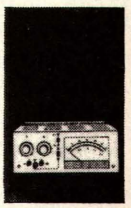

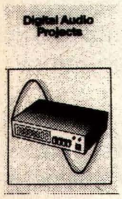

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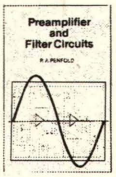

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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **HDTV costs.** No matter which of the five proposed HDTV systems is chosen, receiver costs are expected to be about the same. That's the conclusion of a report made to the FCC Advisory Committee on Advanced TV Service, detailing the most complete study of receiver costs made to date. The Specialist Group on Advanced TV Receiver Cost, consisting of representatives of all HDTV system proponents and engineers from receiver-manufacturing companies, found that by 1998 (which was assumed to be the first year of true mass production) the average HDTV receiver with a 34-inch widescreen (16:9) tube could retail for about $2550 and a 56-inch projection set could sell at around $3850.

These findings are interesting in view of the fact that the first two widescreen (non-HDTV) sets to be announced for the American market—a 34-inch tube set under the RCA brand and a 50-inch projector by Panasonic—both will carry suggested list prices of $4999.

The HDTV cost study group found that no proposed HDTV system had a significant cost advantage as far as receivers are concerned. Electronics in 34-inch sets varied from $216 to $258 in cost, and for projectors from $305 to $374. Cabinet cost of all 34-inch sets was estimated at $90, and for projectors at $140. The tube price was put at $700; projection optics, tubes, screen, and assembly at $1050. Retail prices were estimated by adding the normal 2.5 multiplier for various markups.

The specialist group threw cold water on those counting on new giant picture-on-the wall displays to replace CRT-based systems. "The cost of future displays with various flat panel technologies and light-valve projectors could not be estimated with any degree of accuracy, because no such displays appear ready for consumer HDTV at this time," the report stated. "Therefore direct-view CRT and projector technology were assumed to be the most cost-effective displays for the time frame of this analysis."

• **8mm/VHS VCR.** Something that home videographers have been wishing for is on the way. In Japan, Sony has introduced a dual-deck VCR that can edit from 8mm to VHS and vice versa. Both decks have high-end features such as stereo audio and capability of accommodating high-band recordings (Hi8 and S-VHS), but in standard resolution only. Included are several editing features, including jog/shuttle controls. Presumably frightened by the blustering talk of movie-industry association figures, who claim that dual decks are designed to infringe copyrights, Sony says that it has no plans to export the deck to America, but demand could convince it to change its mind.

Competition could do that as well. Go-Video, which introduced the first VHS-to-VHS dual deck to America, says that it will introduce an 8mm/VHS deck here at midyear. So does Samsung, which makes the dual decks for Go-Video.

• **CD-ROM movies.** How do you sell a multimedia system when the public doesn't know what multimedia is? Call it a movie machine. That's the formula that will be followed by Denon America, according to its president, Robert Heiblim. People aren't interested in buying something for which they have demonstrated no need and don't understand, Heiblim reasons. Denon is developing a CD-based multimedia system using Intel's Digital Video-Interactive (DVI) system. The most important need is to put regular non-interactive movies on the ROM discs first, according to Heiblim. Consumers know what movies are and will buy videodisc machines that use little five-inch discs, as long as they are superior to existing laserdiscs, he predicts. When many of these CD movie machines are in place, then interactive programming can be inaugurated.

Denon says that its DVI system soon will have laserdisc quality, which is considers a prerequisite for consumer acceptance. Heiblim says that early multimedia consumer products must be marketed as "VTR's," which stands for "videotape replacements," because consumers won't put their money into unknown devices. He prefers to call Denon's system "something that plays movies and is also interactive."

• **Video goggles.** Two companies have demonstrated ski-mask-like contraptions that provide personal video pictures using LCD's. Sony displayed its "Visortron" system in Japan, using two small LCD's that are viewed through built-in lens systems. Since each eye views a separate picture, it's possible to display images in true 3-D. Sony says that it's exploring commercial uses for the product.

But another system, "Virtual Vision sport," was about to go into production at our press time. That system is based on the "heads-up" displays used in aircraft, and uses a single LCD and lens-mirror to display a picture that appears to be as large as 60 inches, 8 to 15 feet in front of the viewer. The picture is off to one side, so the user can perform other tasks while watching it.

The five-ounce wrap-around glasses, with a belt-packed TV tuner, battery, and jacks to connect a VCR, camcorder, or TV cable, will go on sale this spring at less than $900, says its producer, Virtual Vision. An accessory will permit it to pick up wireless signals from the television. Ω

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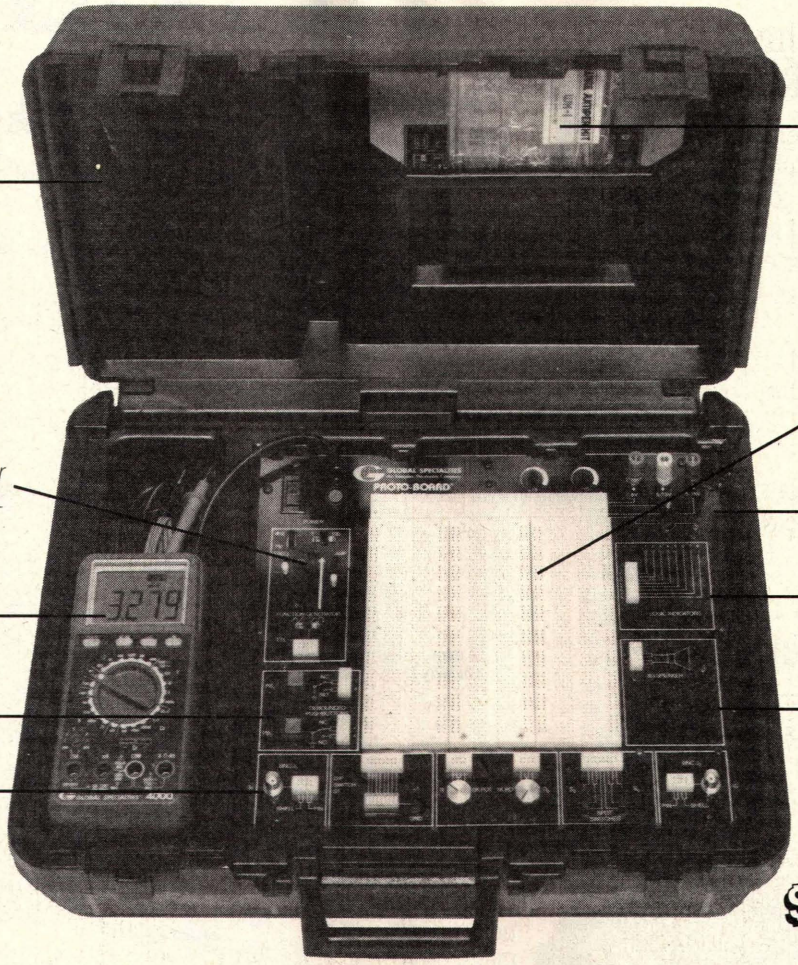

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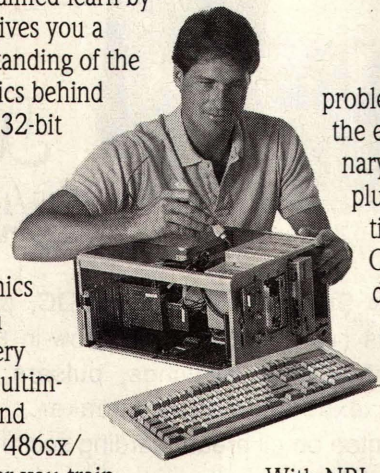

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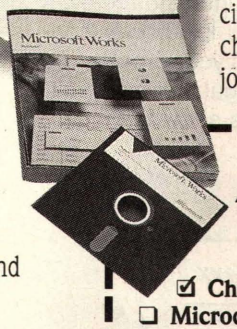

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Q & A

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MONITOR BUG

I have an IBM clone and use it with a monochrome monitor. The system has always been very reliable but recently I've been having trouble with the monitor. I'm not sure what's going on, but the symptoms are that the image flickers randomly. Sometimes it will be perfect for a while and then it will get brighter or darker in random spurts. If I turn the monitor off and then on again, the problem sometimes fixes itself for a while, but it's only a matter of time before the flickering returns. Any ideas?—B. Frish, Los Angeles, CA

You may think of this as a computer problem but any experienced TV person will tell you that this is a simple problem with the clamping circuit on the video input. Most TV's use a combination of diodes and resistors to set the white and black levels to somewhere around a volt or so. Computer monitors do the same.

If you have access to the schematic for the monitor, it should be a fairly simple matter to fix it. All you have to do is locate the relevant part of the circuitry and then take a look at the DC levels with a white and black screen. You'll probably find that one of the diodes is intermittently failing. Changing the bad component is a quick job although it may take a bit of work—with a screwdriver—to get your hands on the component.

If you can't get the schematic for the monitor you can still snoop around with a scope or meter until you locate the clamping circuit. If this is the first time you've ever thought about doing something like this, my advice is to forget about it since there are some real knock-you-down voltages floating around the inside any TV or monitor.

Since the purpose of your letter seems to be getting your computer working again, the best advice is to buy another monitor. You can get a monochrome monitor for under 80 bucks these days and they even come with warranties. If you don't want to scrap your old monitor, take the guts out of it and turn the case into a fish tank. That's what I did with mine!

LIMITING LED CURRENT

I'm building a circuit that has several LED's as indicators to let me know how the circuit is performing. Quite often more than one LED is on at a time, and since the circuit is battery powered, it causes a real power drain. All the LED's have one leg in common so I have no way to control individual brightness. Isn't there some simple circuit that will regulate and limit the current used by the LED's, no matter how many are lit?—W. Meredith, Elkins, WV

I'm not really clear about why you can't use separate resistors on the LED's to individually limit the currents, but there is another way to solve the problem. The 78XX-series of voltage regulators have been around for a long time and are even available in special low-power configurations. If I had your problem I'd use whichever regulator was suitable and wire it as shown in Fig. 1.

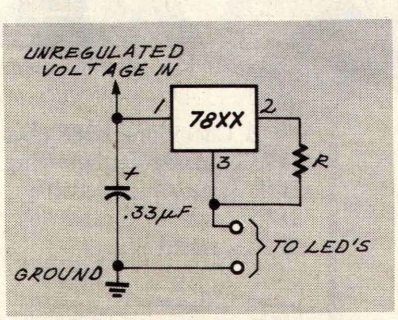

FIG. 1—THE 78XX-SERIES of voltage regulators can be used in a configuration like this to limit current rather than voltage.

You should tailor the value of the capacitor to the number of spikes on the line but, in general, the 0.33 μF capacitor shown in the schematic should work well.

When you set up the regulator as shown, it works as a current regulator rather than a voltage regulator. The output current draw will be the regulated voltage divided by R. The only thing to watch out for is that you don't try to draw more current through the regulator than what it's rated for. But since you only want to drive a handful of LED's, I don't think you'll have any problems.

ONLY HALF-WAY THERE

I have a laser printer that I'm trying to use for printing graphics. The problem is that I can't seem to print more than half a page—the picture is incomplete and the bottom half of the paper is always blank. What's going on?—A. McChord, Ames, IO

Laser printers produce terrific output, but it's amazing that, while so many people use them, so few really understand how they work. The major constraint in printing graphics with a laser printer is the amount of memory it has, and that seems to be your problem as well.

Copy machines and laser printers are very similar. The former uses an optical image as the source of its output and the latter uses an electronic image in memory for the source. If you want to print with 300-dpi (dot per inch) resolution, your printer will need enough memory to "take note" of the image. If there's not enough memory, the printer will print the page when it runs out of memory—which, in your case, is about halfway through the image.

You have two choices to solve the problem. The first is to add memory to the printer, and you'll need at least one and a half megabytes of RAM to do a 300-dpi full-page

Continued on page 86

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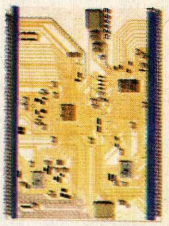

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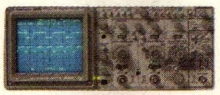

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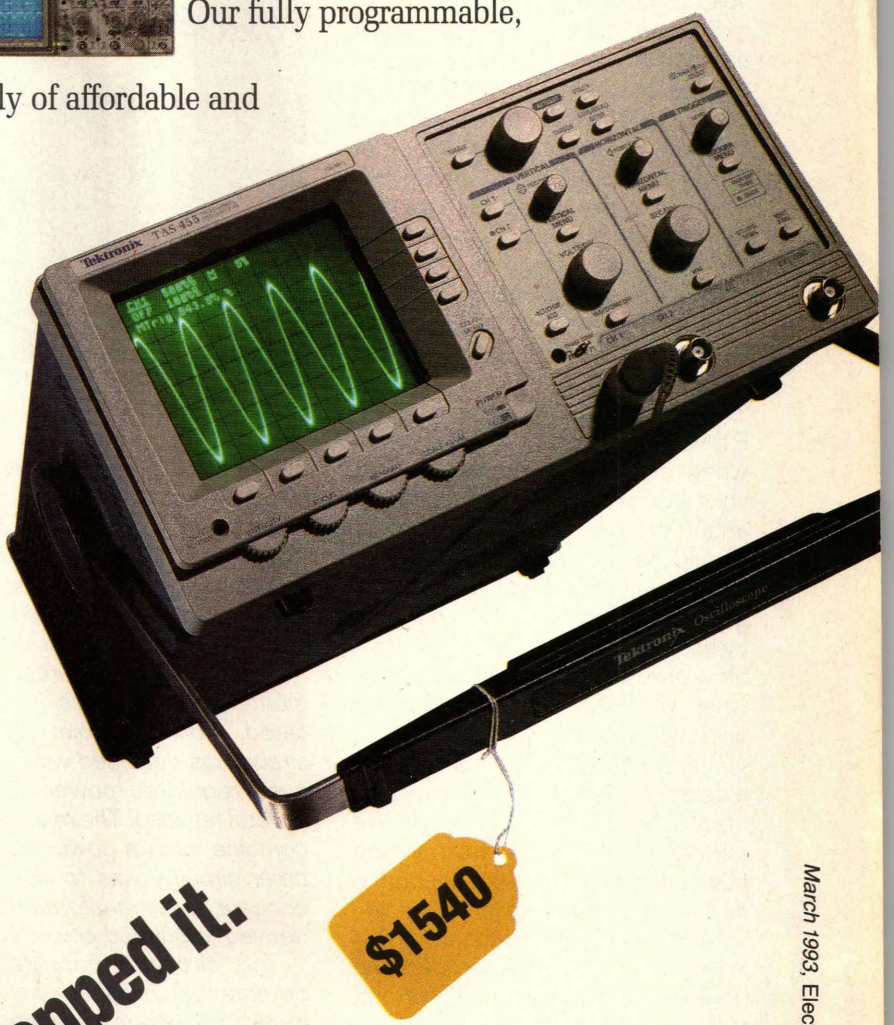

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LETTERS

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INRUSH CURRENT LIMITER CORRECTIONS

There are two problems with the "Inrush Current Limiter" (*Electronics Now*, December 1992).

First, in Fig. 6 on page 49, the emitter of Q2 and the high end of R5 should be connected to the plus end of C2 (about 24 volts DC). As shown, the Darlington transistor, Q2, and possibly the relay, RY1 (24-volt DC coil) would burn out.

Second, the circuit is too complicated and overdesigned. I designed a much simpler circuit, shown here in Fig. 1 (a) and (b). The relay RY1 will not activate until the resistance of the NTC thermistor R_T drops low enough for the voltage across RY1 to reach about 80 volts (or whatever the activating voltage for the relay used might be). Resistor R1 might be added to slow down the action by effectively boosting the needed voltage.

Find the maximum resistance (of R1) with which the relay will activate when connected directly to 120 volts AC, and then use a resistor of about half that value. That resistor should be shorted out by another set of contacts of RY1. The effectiveness of the circuit can be seen by finding values of fuses at the just-blow threshold (or just not-blow) when the circuit is used and not used (R_T shorted out).

I cannot think of an instance when a delay of one second (or more), as stated in the article, would be needed. (If the capacitors in the power supplies need one second to recharge after a spike in the loading current, I would say that the circuit is in peril, and a major redesign of the power supply is needed.) Therefore, the circuit shown here should do the same job nicely.

PTER PESKA
Taylor, MI

In addition to responding to Mr. Peska's comments, I would like to point out several errors that appeared in the article. There is, indeed, an error in Fig. 6 on page 49. The emitter of Q2 and the high end of R5 should be connected to the positive end of C2 (i.e., the positive 24-volt supply). The parts placement diagram, Fig. 7, is correct.

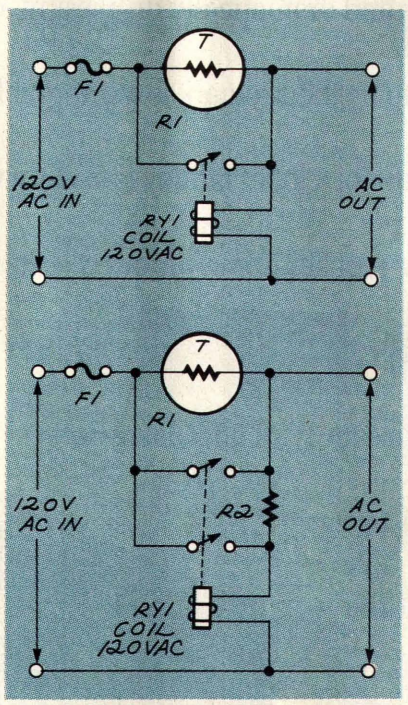

FIG. 1—TWO ALTERNATIVE INRUSH current-limiting circuits.

In response to Mr. Peska's comment that the circuit is "too complicated," I'd like to point out that the circuit was designed with a line-derived regulated power supply for several reasons. The main reason to combine such a power supply and timer circuitry was to illustrate the concept of a transformerless line-derived, regulated power supply.

This circuit is popular in such commercial products as remote-controlled lamp/appliance controllers. Other advantages of the circuit are that it is independent of the load connected to it, and it features a predictable and easily adjustable time delay. Finally, the circuit is not that "complicated" in the first place: It does not consist of many components, and it is easy to construct. I agree that Mr. Peska's circuit is much simpler and will work, but my project was designed for the reasons stated in the article.

My response to Mr. Peska's comment that a delay of more than one second is unnecessary is that the circuit allows for a wide range of delays by appropriate selection of a fixed resistor or by the use of a variable resistor. Delays of one second or less are easily obtained by choosing a suitable resistance (simply reduce the value of R4). Again, the wide range of time delays possible was given in Table 1 to illustrate the versatility of the circuit.

In the parts placement diagram (Fig. 7), resistor R8 should be labeled MOV1, R9 should be labeled R8, and R10 should be labeled R9 (there is no R10 in the circuit).

In the first sentence of the last paragraph on page 48, the sentence containing the phrase "shorts out thermistor R9" should read "shorts out thermistor R8."—Douglas Wirth

AUDIO UPDATE COMPLAINT

Larry Klein's November *Audio Update* contains gross errors and unwarranted assumptions, and it is insulting to audiophiles and readers. For example: The "Hafler test" shown in Fig. 1 has a fatal error in that the amplifier is not evenly loaded. Changes in an amplifier's load usually alter the response of the system significantly, and this change would be included in the null speaker signal.

Klein assumes that a better amplifier will make a better system; this is not necessarily so. The equipment surrounding an amplifier will interact with the amplifier for better or worse, and this makes it difficult to judge an amplifier accurately without considering the related equipment. For this reason, respon-

sible reviewers list the equipment used with the unit under test.

Klein also ignores the fact that audiophiles have a wide range of music preferences that influence equipment purchasing decisions. I argue that one can objectively evaluate equipment, but must include other factors such as performance expectation and personal musical preference.

Klein fails to recognize that sophisticated listening skills take time and effort to develop into a useful tool for evaluating high-end audio equipment. I find his attitude typical of those whose hearing is undeveloped and whose experience seems to be the result of confiding in salesmen, listening to rumors, and "wannabe" experts. Klein's incompetence is so complete that he probably would even claim that CD's sound better than records, contrary to what is obvious.

S.D.

Address withheld by request

Mr. Duncan's long letter (heavily condensed for space reasons) contains several technical and philosophical confusions—aside from being stupid and insulting. To start:

The Hafler circuit shown in Fig. 1 of my article connects the "null" speaker so it can compare only the input and output of the right channel, which is loaded with a conventional speaker. The resistance loading on the left channel output simply provides the input signal for the right channel.

If I understand Mr. Duncan correctly, he believes that it's more important to match the complementary defects of amplifiers and other equipment than to seek the best performance from each. Since well-designed power amplifiers—which were the subject of my article—are essentially audibly perfect within their power ratings, Mr. Duncan's mix-and-match approach is chasing a wild goose up a blind alley. Incidentally, the only "responsible" high-end reviewers that I know about write for The Audio Critic, mentioned last month.

As to my inexperience in critical listening, I became an avid audiophile in the early 1950's when hi-fi equipment first became available in the U.S. For five years I worked as a technician for an electronics kit manufacturer, where I made tests, did repairs, and handled the technical correspondence on my employer's kits that included hi-fi kits. In the evenings and on weekends I "moonlighted" as a freelance hi-fi serviceman.

After being a technical editor at Popular Electronics for two years and a similar magazine for another two years, I became the technical editor of Stereo Review, where I was in charge of its equipment-testing program for about 20 years. During that time I auditioned countless products in my home and office listening room.

Moreover, I was invited to visit the test laboratories and factories of audio equipment manufacturers in England, Germany, Japan, Denmark, Hungary, Austria, Canada, and the U.S. during that 20-year period. At all those locations I was asked to evaluate the sound of their products (mostly loudspeakers), and I frequently was able to validate my responses against objective test data.

I do not "confide" in salesmen, rumor[monger]s, and "wannabes." However, I know many product engineers and audio researchers—and guess what—most of them agree with me that, in general, CD's do sound better than LP's—if only for their superior signal-to-noise ratio.

It's always good to hear from a fan.—Larry Klein

AN AUDIO/VIDEO-PHILE

I recently discovered *Electronics Now*, checked out every back issue from my public library branch, and spent many rewarding hours reading each one from cover to cover. I can't follow everything yet, but I expect that will come with time.

On a general note, I enjoyed Larry Klein's debunking of some of those outrageous claims from audiophiles. I now have an authority to quote when I say that I cannot discern any significant difference between my $5000 equipment and the $20,000 worth of equipment that is supposedly being installed in average 18 ×15-foot American living rooms.

I haven't seen one subjective au-

continued on page 70

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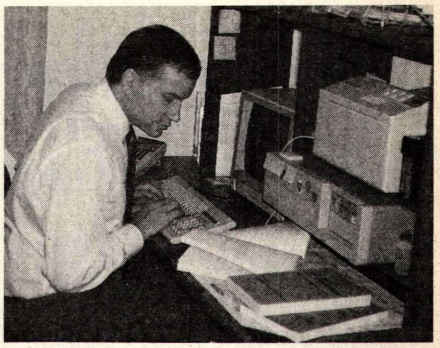

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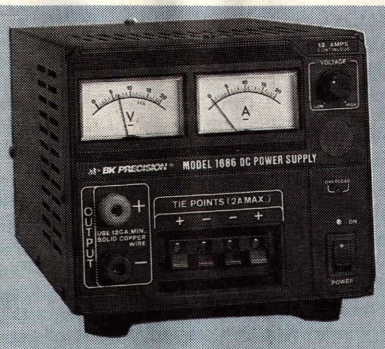
B+K Precision Model 1686 DC Power Supply

Power your 12-volt equipment with this rugged supply.



CIRCLE 10 ON FREE INFORMATION CARD

Whether powering a prototype circuit or providing power for equipment being serviced, the bench-top DC power supply is an essential tool for anyone in the electronics industry. It's also essential for any anyone who plays an active role as an electronics hobbyist. B+K Precision (6470 W. Cortland St., Chicago, IL 60635) has recently introduced the *Model 1626,* a supply that is ideal for powering equipment rated at 12 volts.

The *1686* can deliver an output from 3 volts to 14 volts DC with a maximum current of 12 amperes. That high current rating is sufficient to power most car stereo systems, even those with high-power amplifiers. Most mobile amateur radio equipment, as well as CB transceivers, marine radios, and other high-current automotive accessories can be powered safely from the *1686.*

The maximum output current available from the power supply is proportional to the output voltage. When the supply is set to deliver 13.8 volts—which is the operating voltage for most equipment nominally rated at 12 volts—the *1686* can deliver 12 amperes continuously to the load. That drops to 10 amperes at 12 volts, 4.5 amperes at 5 volts, and 2.5 amperes at 3 volts.

At all voltage settings, the specified load regulation is less than 0.8% That is, regardless of the load at the output terminals, the supply's output voltage will deviate less than 0.8% from its initial setting. The line regulation of the supply is also rated at 0.8% from 108–132 volts AC. That means that regardless of the change in the line voltage to which the supply is connected, the output voltage will deviate less than 0.8%. The ripple and noise is specified at less than 10 millivolts rms. Overload current limiting provides protection against excessive overload or short-circuit output.

The *1686* is housed in a black metal cabinet that measures about 5½×6×12 inches; it weighs just over 12 pounds. The front panel features a pair of easy-to-read analog meters along the top edge, one for voltage and the other for current—that provide an indication of what the supply us doing at a glance. To the right of the meters is a rotary knob that controls the output voltage. The bottom half of the panel contains two sets of output connectors, a power switch, and two LED indicators.

The main voltage-output is provided on a set of binding posts. Two sets of spring-loaded terminals—much like the kind commonly found on audio speakers—are provided for connecting low-current loads. The tie points can supply a maximum of 2 amperes. Above the power toggle switch is an LED that serves as a power-on indicator. Above that is an LED that indicates that the supply is in an overload condition and has reduced its output voltage.

The rear panel contains a fuse holder and a small fan. The fan, which helps to keep the supply compact by reducing the size of the heatsinks needed, does not run constantly. Rather, it is controlled by a thermostat, and comes on only when the internal temperature of the supply is too high for safe operation.

The outputs of the supply are isolated from the chassis and earth grounds, which is essential for flexibility in connections. If required, for example, the positive output can be connected to ground for powering positive-ground automotive equipment.

The isolated outputs also allow multiple supples to be connected together in series or parallel for powering equipment that has higher voltage and current requirements. For example, connecting two supplies in parallel will provide a continuous source of 24 amperes, while connecting two supplies in series will provide an adjustable 6 to 28-volt power supply.

The model *1686* can operate from either 120-volt or 230-volt AC power lines with frequencies of 50 or 60 hertz. A slide switch on the bottom of the chassis permits easy selection.

We found the operation of the model *1686* to be quite straightforward. The manual supplied with the supply was more than adequate, and we were happy to find that calibration instructions were included there.

B+K Precision has priced its model *1686* at $199. We think that the supply is ideal for service shops that regularly repair mobile equipment, as well as for retailers who need to power equipment on display. Of course, radio amateurs will also appreciate the 12-ampere continuous duty rating. Ω

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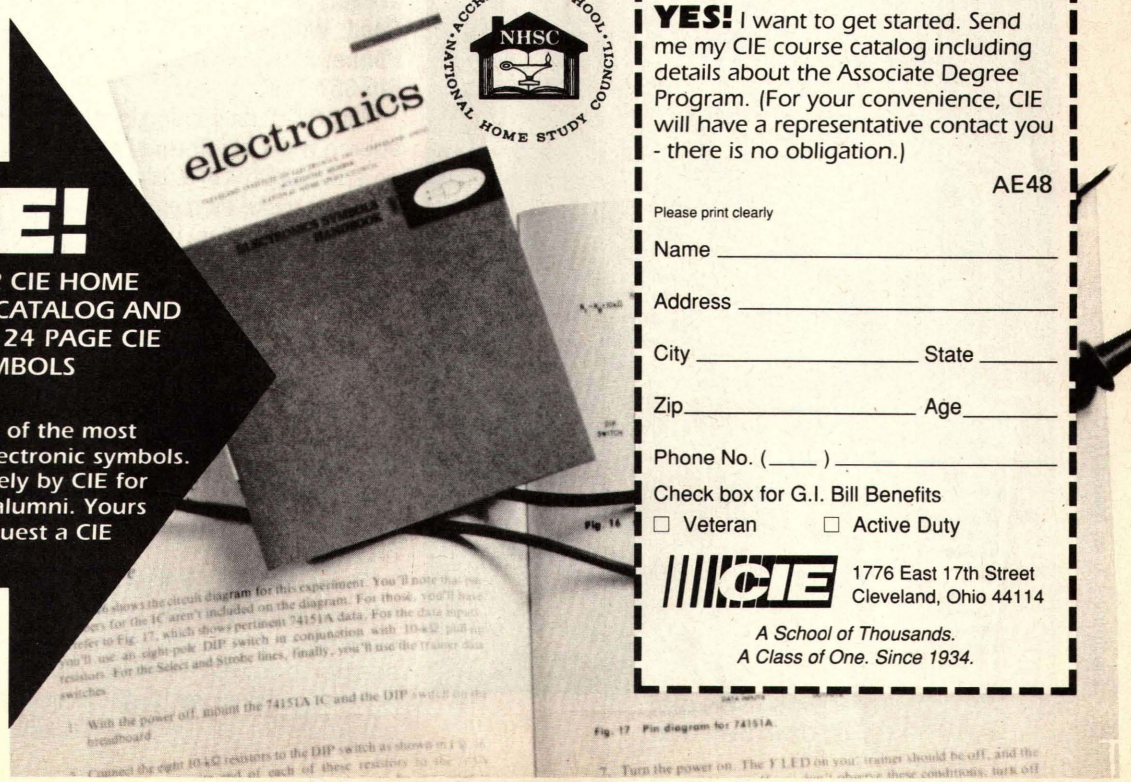

NEW LIT

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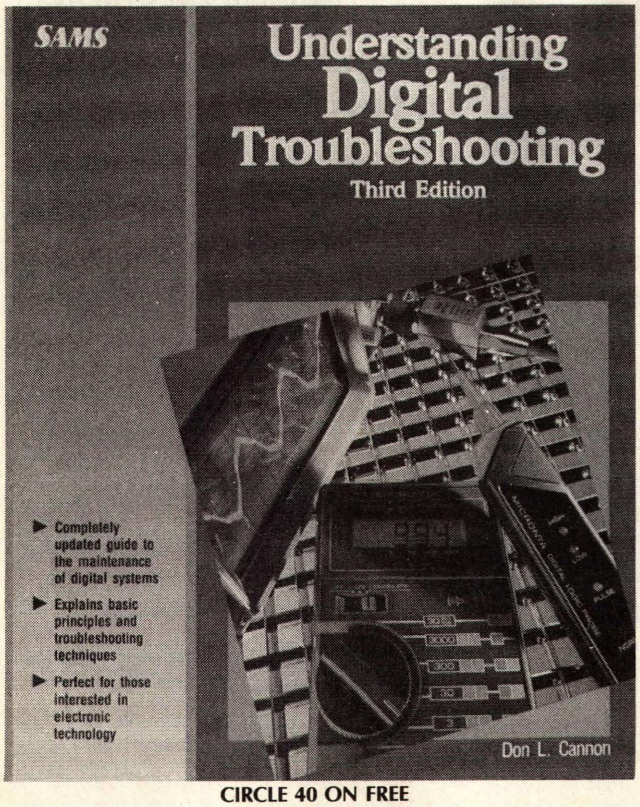
Understanding Digital Troubleshooting: Third Edition; by Don L. Cannon. Sams, Division of Macmillan Computer Publishing, 11711 North College, Carmel, IN 46032; Phone: 800-428-5331 or 317-573-2500; Fax: 800-448-3804 or 317-573-2655; $24.95.

Digital systems must be effectively maintained if they are to operate reliably at peak performance levels. That is the central theme of Don Cannon's book on troubleshooting digital electronics. Mixing general tutorial information with "how to" instruction, the book is intended to help readers keep their digital circuits operating properly "in the pink."

Intended for readers with a wide range of experience and formal technical background from the novice hobbyist to the experienced professionals, Cannon's book includes comprehensive text on basic electronic engineering concepts and the fundamentals of digital circuitry. After readers have learned (or refreshed their knowledge) of the fundamentals, they will be ready to start troubleshooting.

Cannon explains how to locate faults in digital circuitry and make repairs of increasing complexity on everyting from simple control circuits to computers. Chapters cover the techniques for troubleshooting with advanced timing techniques, analysis of serial, parallel, synchronous, and asynchronous circuits, signal tracing, and the use of logic clips and probes, and other specialized digital test equipment.

The book also covers the solution of problems in sequential logic circuits, how to test complex digital devices, and how to select logic analyzers and computer test equipment appropriate to the maintenance task at hand. Each chapter includes a self-quiz to permit readers to evaluate their progress and understanding of the subjects to which they have been introduced.

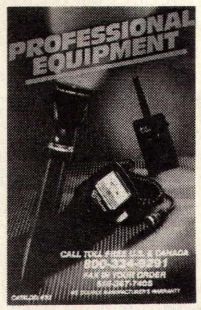


CIRCLE 40 ON FREE INFORMATION CARD

Professional Equipment, Catalog No. 33. Professional Equipment, 153 Plainview Road, Woodbury, NY 11797; Phone: 800-334-9291; Fax: 516-367-7405; free.

This 36-page catalog is a source book of information on specialty tools available for such tasks as maintaining air conditioning, heating and ventilating equipment, monitoring the environment, and inspecting industrial equipment. Pictures and information are provided in the catalog for the latest moisture meters, gas detectors, circuit analyzers, flow meters, and industrial electronic test equipment.

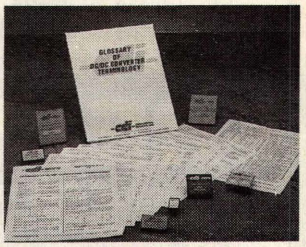
Catalog No. 33 will be of interest to maintenance engineers, architects, and inspectors, as well as those with responsibilities for the enforcement of electrical and fire safety codes. Use Professional Equipment's toll-free phone number to learn what specialized tools are available for your specific maintenance and inspection tasks.



CIRCLE 39 ON FREE INFORMATION CARD

Glossary of DC/DC Converter Terminology. Conversion Devices, Inc., 15 Jonathan Drive, Brockton, MA 02401; Phone: 508-559-0880; Fax: 508-559-9288; free.

This 10-page application note is the first in a planned series from Conversion Devices, a designer and manufacturer of DC/DC converters. It contains more than 180 definitions of terms commonly associated with DC/DC converters and power supplies. Arranged in alphabetical order, the technical terms are simply and completely explained. Ω



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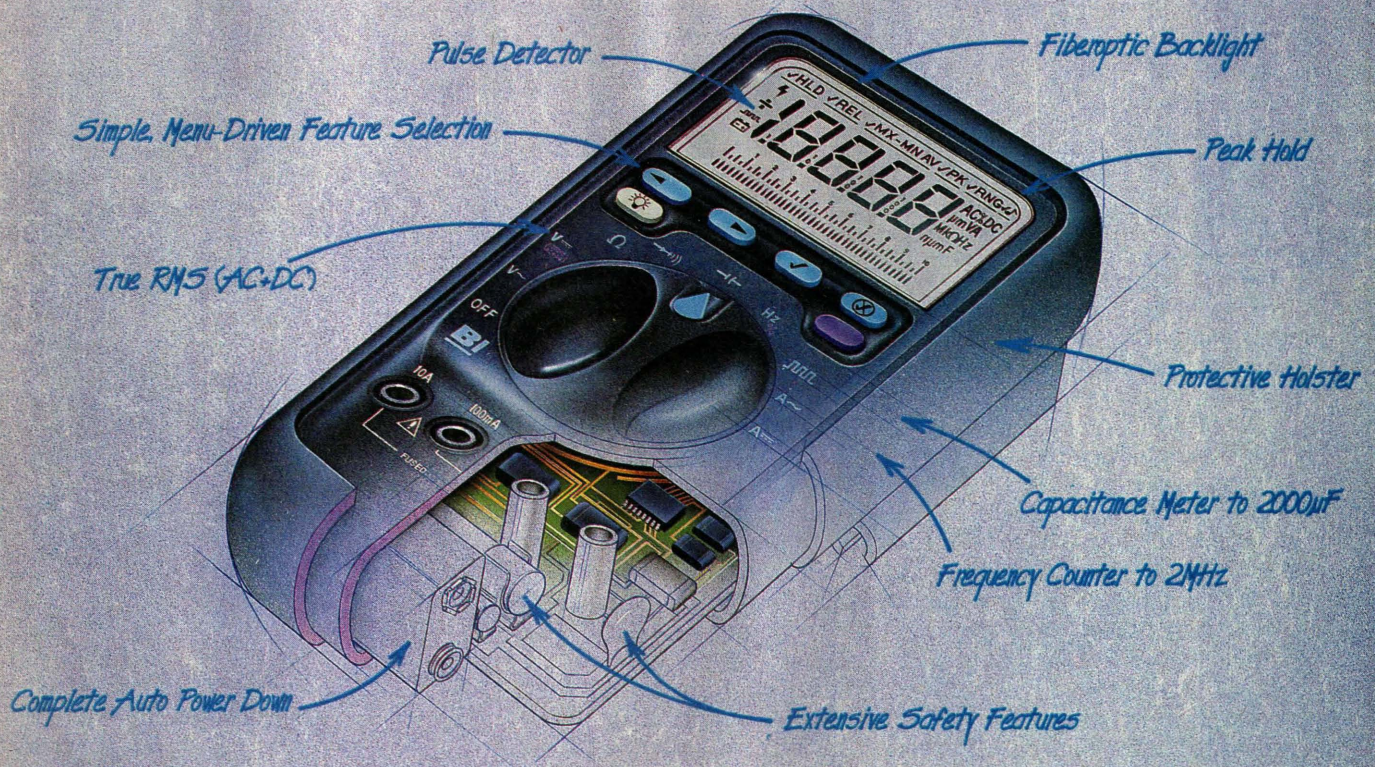

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*BI (formerly Beckman Industrial Instrumentation Products Division) is now a part of Wavetek Corporation.

CIRCLE 98 ON FREE INFORMATION CARD

NEW PRODUCTS

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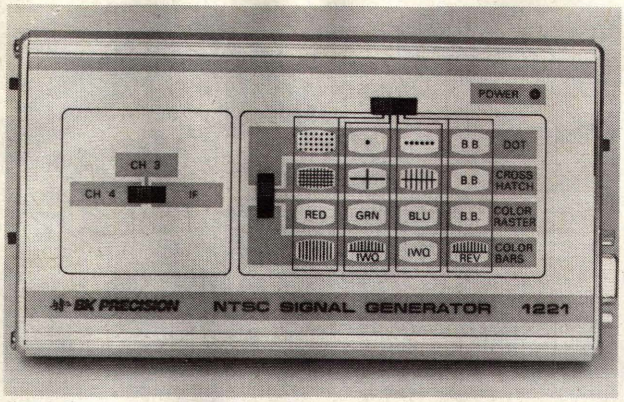
HANDHELD NTSC COLOR GENERATOR. A television/video signal generator small enough to fit into a field-service kit is now available from *B+K Precision*. *The Model 1221*, said to offer the same capabilities usually found only in bench models, generates 14 patterns of stable video signals for testing, servicing, and adjustment of TV's and other video equipment.

The generator's patterns include standard NTSC color bars (with and without IWQ), full-field IWQ, split-field color bars with reverse bars and red, green, blue, and black rasters. It also offers six convergence patterns. For monochrome tests, the chroma can be turned off to display the luminance level only. A 1-kHz subcarrier audio tone can also can be switched on or off.



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Generator outputs include composite video, IF (45.75 MHz, crystal-controlled), and CH3 and CH4 (crystal-controlled). For testing CGA computer monitors, a 9-pin D-type connector provides an RGB output. The user can select either interlaced or progressive scan, TTL or low-level (analog level) for RGB outputs.

The *Model 1221* is housed in a rugged, lightweight aluminum case that acts as an RF shield. It can be powered by the included AC adapter or an external 12-volt DC to 18-volt DC source.

The *Model 1221* NTSC color signal generator is priced at $369.

B+K Precision
Chicago, IL 60635
Phone: 312-889-1448
Fax: 312-794-9740

CIRCLE 17 ON FREE INFORMATION CARD

UPGRADED 90 SERIES SCOPEMETER. *Fluke's upgraded ScopeMeter* combines a 50-MHz, 25-megasamples per second dual-channel digital storage oscilloscope with a digital multimeter. It has been given a Version 4 software upgrade.

This *ScopeMeter* includes a lot of new features intended to improve its flexibility and "user friendliness." They include percent duty-cycle measurements for pulse-width modulated signals in control circuits, 30-ohm range, and 0.01-ohm resolution for tracing elusive shorts. Other new features include a "time stamp" to mark the occurance of minimum and maximum values, waveform inversion on both channels for easier calculations, and increased frequency-counter resolution.

The upgrade also includes circuitry that returns the instrument to previous settings when changing between the meter mode and the scope mode. Additional record functions are included, and there is continuous meter-mode display of voltage, frequency, and duty cycle. A smart trigger algorithm allows hands-off duty-cycle measurements of pulse-width modulated motor-control waveforms.

The three *ScopeMeters* (Models 93, 95, and 97) offer oscilloscope and digital multimeter functions. They all include such features as autoset, waveform and setup memory, combined display of meter results and waveforms, and convenient menus. The *Model 97* also features a built-in signal generator, a component tester, and remote control through an optically isolated RS-232 interface, printer interface, and display backlighting.

The price of the *ScopeMeter* Model 93 is $1350, the Model 95 is $1650, and Model 97 is $1950. Upgrades of earlier *ScopeMeter's* are $155.

John Fluke Mfg. Co., Inc.
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FOIL-SHIELDING TAPES KIT. Foil-shielding tapes are now available from *3M* in convenient kits. Each kit contains 3M's full line of shielding tapes organized in a compact dispenser box. The Scotch brand tapes are intended for reliable point-to-point electrical contact. Examples of applications include EMI/RFI shielding, grounding, and electrostatic-charge draining.

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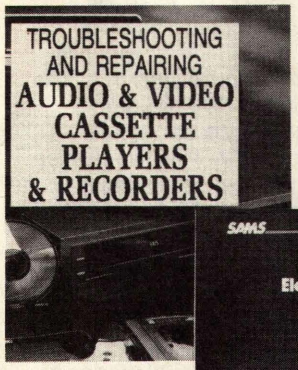

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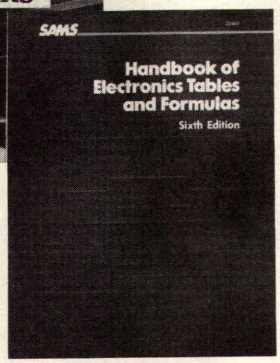

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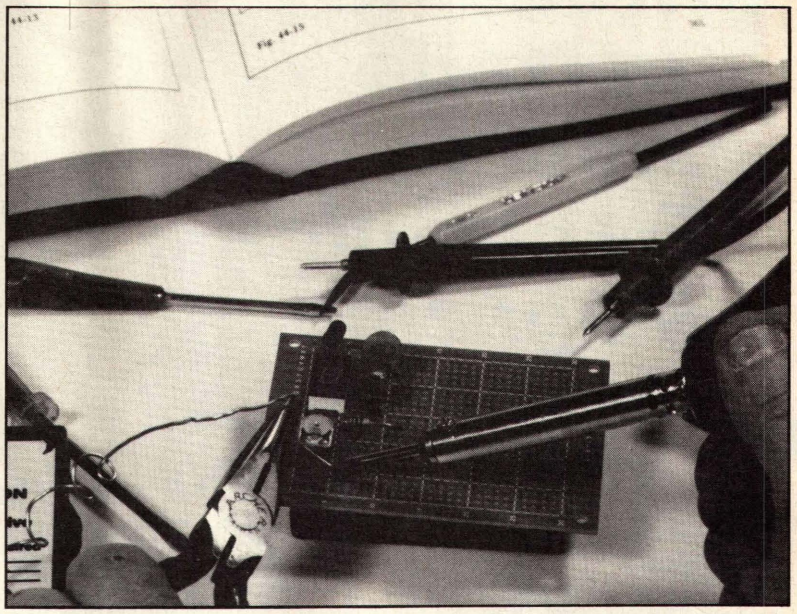

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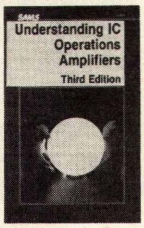

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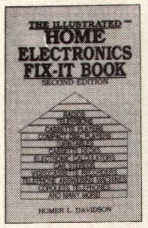

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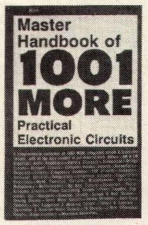

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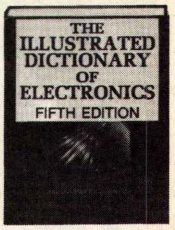

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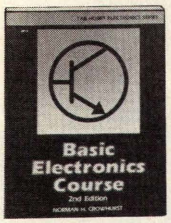

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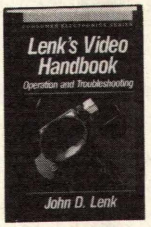

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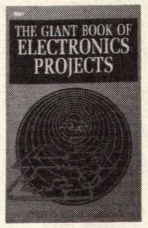

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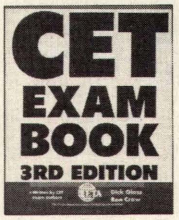

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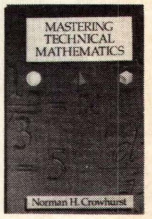

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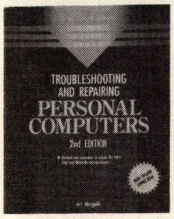

3677-XX $34.95
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3671P $18.95
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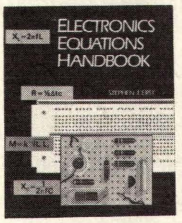

3241P $16.95
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3374P $16.95
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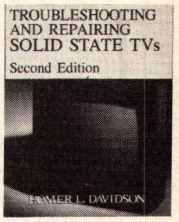

3700-XX $36.95
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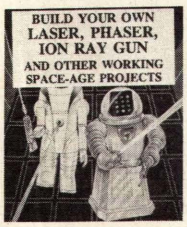

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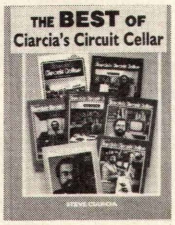

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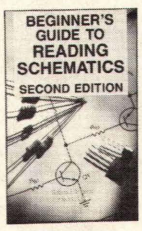

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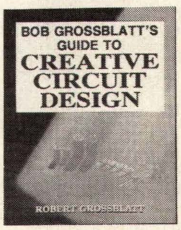
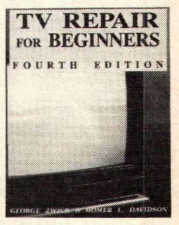


3610 $28.95



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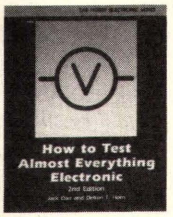

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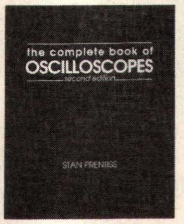

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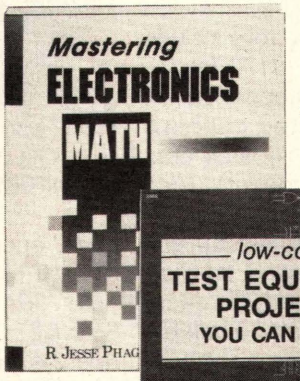

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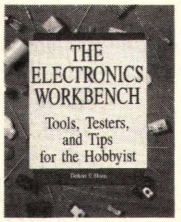

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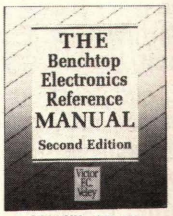

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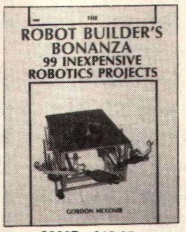

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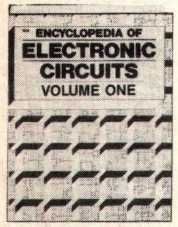

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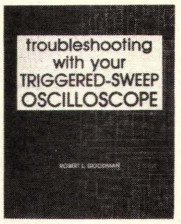
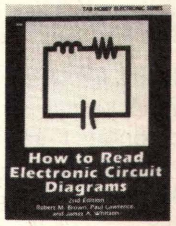


3669 $27.95



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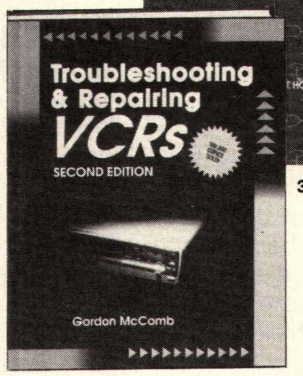

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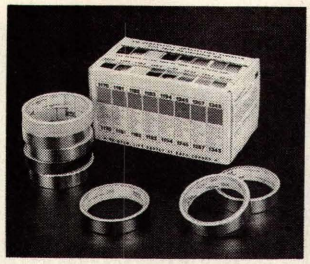

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four-yard-long rolls include one each of: *1170* (aluminum), *1181* (copper), *1182* (double-coated copper), *1183* (tin-alloy-coated copper), *1194* (copper), *1245* (embossed copper), *1267* (embossed aluminum), and *1345* (embossed tin-alloy-coated copper). Replacement rolls are available from the same source as the kits.

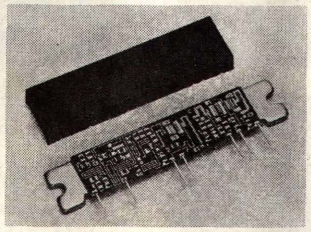
The kit simplifies the task of finding the right tape when it is needed. The 4 × 4 × 7.5-inch container is labeled with useful technical and applications information about the tapes: product number, backing, adhesive type and thickness, adhesion, resistance, and shielding effectiveness.

3M Electrical Specialties Division
Building 130-3N-56
6801 River Place Blvd.
Austin, TX 78726-9000
Phone: 1-800-328-1368.

900-MHz RADIO POWER MODULE. *Motorola* has introduced 7.5-volt RF power modules that operate in the 806–940-MHz frequency range with an input power of 1 milliwatt and an output power of 4 watts. The *MHW804 Series* is intended for cellular telephone, trunking, or other two-way radio systems.

The series includes two modules that differ only in operating frequency band. Both are packaged in cases less than ½-inch wide. According to Motorola, the modules are exceptionally stable, rugged, low in harmonics, and have wide dynamic ranges.

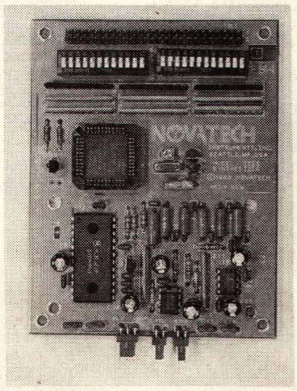
The *MHW804-1* operates in the 800 to 870-MHz range, and the *MHW-804-2* operates in the 896 to 940-MHz range. The *MHW804-1* is priced at $50.82 and the *MHW-804-2* is priced at $52.36 in 1 to 399 quantities.



CIRCLE 19 ON FREE INFORMATION CARD

Motorola, Inc.—E114
5005 East McDowell Road
Phoenix, AZ 85008
Phone: 602-244-4597
Fax: 602-244-4597

DIRECT DIGITAL SYNTHESIZER KIT. This direct digital synthesizer from *Novatech* can produce output signals up to 12 MHz. The *DDS-3* direct digital synthesizer kit can be programmed to produce sine and TTL/CMOS-compatible signals from 2 Hz to 12 MHz in 2 Hz steps. Its output frequency is set with a 23-bit binary word introduced by DIP switch or ribbon cable.



CIRCLE 20 ON FREE INFORMATION CARD

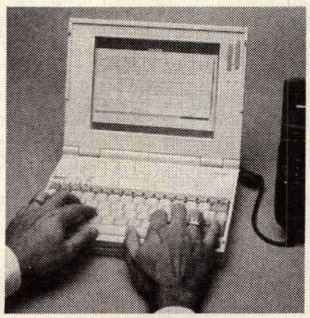
The synthesizer's output amplitude is 1.4 volts peak-to-peak into an open circuit. Fast switching of the output frequencies can be obtained because the transition time for changing frequencies is less than 250 nanoseconds. Spectral purity is specified as better than −90-dBc phase noise at 1-kHz offset, −45-dBc spurious, and −40-dBc harmonic.

Stability is specified as better than 10 ppm. The *DDS-3* is powered by ± 5-volt DC power. The kit includes a 3.5 × 4.5-inch printed circuit board and all necessary parts.

The *DDS-3* kit is priced at $119.95 plus $5 for shipping and handling.

Novatech Instruments, Inc.
1530 Eastlake Ave. E.,
Suite 303
Seattle, WA 98102
Phone: 206-328-6902
Fax: 206-328-6904

CELLULAR NOTEBOOK LINK. A prominent Finnish electronics manufacturer has introduced its *Cellular Notebook Link*. *Nokia* designed the link for use with Compaq notebook computers equipped with the *SpeedPAQ 144* modem and *Nokia 121* cellular phones. The link permits data and fax transmissions to be sent and received over a cellular network.



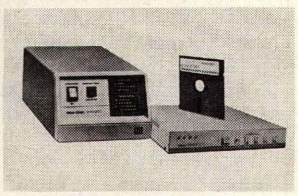
CIRCLE 21 ON FREE INFORMATION CARD

The interface is a coiled cable with a quick-release data cradle that holds the phone while it is in the fax/data mode. That design eliminates the separate interface box required in most mobile data installations. The link needs no external battery because the interface is powered by the phone's battery and the computer's internal power source.

When used with the Compaq SpeedPAQ 144 modem, the *Cellular Notebook Link* transmits data at 4800 bits per second. However, if the data is compressed, Nokia says the data throughput will exceed 11,000 bps. Fax transmissions are sent and received at 9600 bps.

Nokia Mobile Phones, Inc.
2300 Tall Pines Drive
P.O. Box 2930
Largo, FL 34649-2930
Phone: 813-536-5553
Fax: 813-530-7245

STANDBY POWER SUPPLIES. *Perma Power Electronics* is offering a series of standby power systems for backing up computers and peripherals if power fails. *WatchDOS* supplies can be used with any DOS-based computer or network, but cannot be used with Windows or memory-management software. Each system includes a "Hibernate" software utility program.



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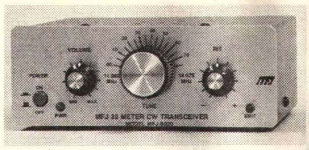
When AC-line power fails, the software detects a signal from the backup power supply, transfers conventional, expanded, and extended memory and

data to the hard drive, and then safely shuts down the computer. When AC power is restored, the software system restarts the computer, restores all memory, and resumes program execution at the point of power interruption.

The 400-VA *Model DPS-400I* is priced at $299 and the 600-VA *Model DPS-600L*, for single personal-use 386 computers, has price of $375. The 800-VA *Model DPS-800L*, for office 386 and 486 computer systems, has a price of $489.

Perma Power Electronics, Inc.
5601 West Howard Avenue
Niles, IL 60714
Phone: 708-647-9414
Fax: 312-763-8330

CW TRANSCEIVER. This 5-watt, 20-meter CW transceiver covers the 14.000- to 14.075-MHz band. *MFJ Enterprises' MFJ-9020*



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compact transceiver measures only 2.25 ×6 ×6.5 inches. It has a sharp, 8-pole crystal filter, 500-Hz bandwidth, and Vernier tuning. The tranceiver has a 5-watt transmitter, a superheterodyne receiver, audio-derived AGC, CW sidetone, and a built-in speaker with an earphone jack. The *MFJ-9020* is powered from 12 to 15 volts DC, and it fits in a briefcase.

The price of the *MFJ-9020* CW transceiver is $179.95.

MFJ Enterprises, Inc.
P.O. Box 494
Mississippi State, MS 39762
Phone: 1-800-647-1800
Fax: 601-323-6551.

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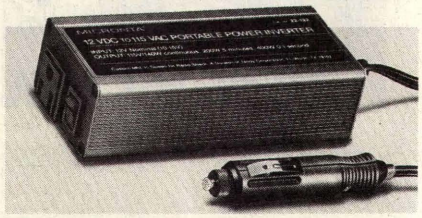

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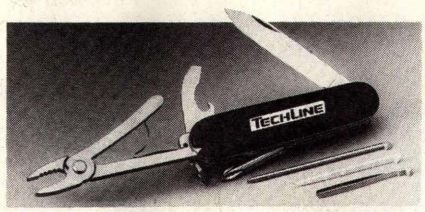

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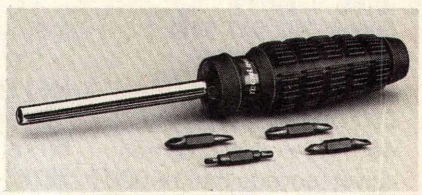

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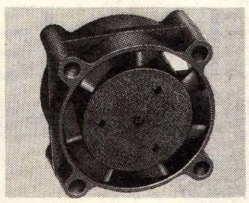

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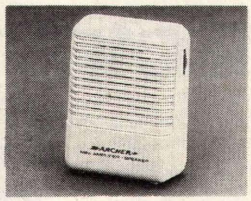

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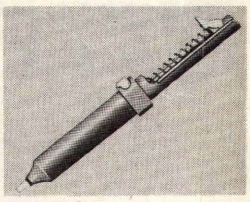

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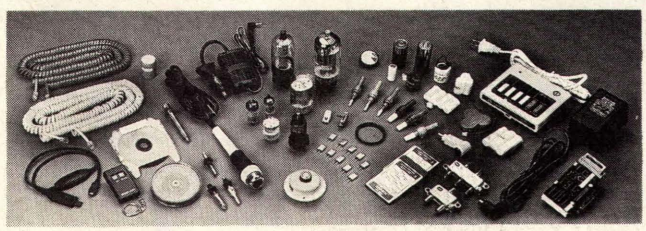

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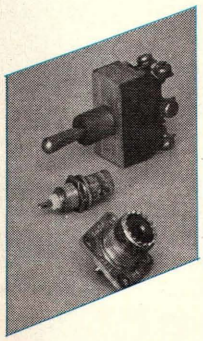
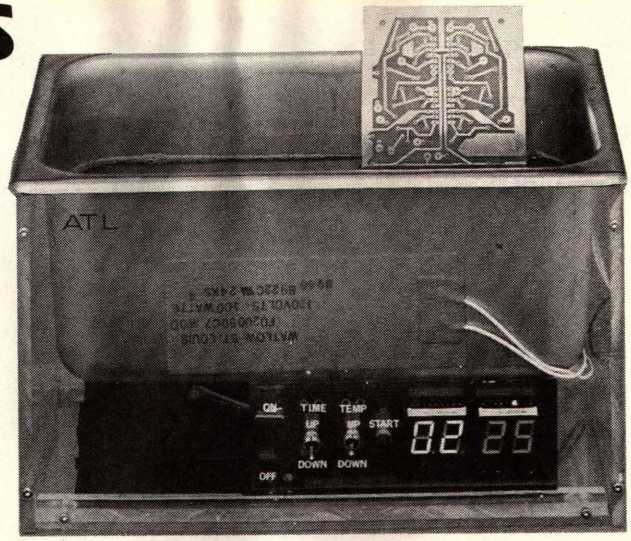
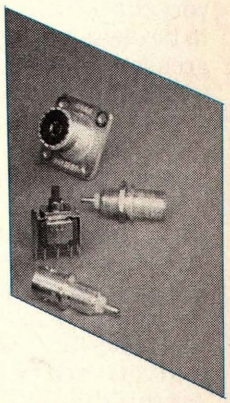






ULTRASONIC CLEANER

Build a professional-quality ultrasonic cleaner and keep hard-to-clean connectors, parts, and tools spic and span.

REINHARD METZ

ULTRASONIC CLEANING HAS BEEN commonplace in commerce and industry for years, particularly for cleaning small, convoluted parts that would be a difficult or impossible to clean otherwise. Items that are routinely cleaned ultrasonically include machine parts, standard and miniature tools and connectors.

Factory-made ultrasonic cleaners are still too expensive for the average consumer and hobbyist. But with the drawings, photos, and text in this article, you can build your own ultrasonic cleaner. You have options in building this ultrasonic cleaner. You can build the complete system with microprocessor-based time and temperature controls, or you can build only the basic model with on-off controls. You'll be surprised at the low-cost of the parts, regardless of the option you choose. The basic specifications for the ultrasonic cleaner are given in Table 1.

Only non-toxic, non-flammable solutions will be needed to do effective cleaning with this ultrasonic cleaner. You'll be able to clean many different kinds of household or shop objects that are hard to clean—or, in the past, have just been too much trouble to clean well with conventional methods. Those objects include jewelry, kitchen utensils, circuit boards, bicycle and auto parts, and tools. What is more, you can do all your ultrasonic cleaning indoors—you don't have to go into your garage or backyard to keep noxious fumes out of your house.

Ultrasonic cleaning

The basis for ultrasonic cleaning is a bubbling action in a fluid called *cavitation*—millions of tiny bubbles forming and collapsing within the cleaning solution do the scouring. You have probably seen the cartoons of thousands of cleaning bubbles at work on the TV commercials for bathroom cleaners. The big difference here is that with our cleaner, the bubbles are created ultrasonically by piezoelectric transducers, not by the solution itself.

The disk-shaped piezoelectric transducers are bonded to the underside of the cleaning pan. The dimensions of these barium-titanate ceramic disks change continuously in response to high-frequency signals applied across their sensitive surfaces. These transducers are similar to those used

TABLE 1
LEADING SPECIFICATIONS FOR THE ULTRASONIC CLEANER

Transducers	piezoelectric
Operating frequency	40 to 60 kHz
Cleaning pan capacity	¾ gallon
Microcontroller	Intel 8751
Timing range*	1 to 99 min.
Solution temperature w/heater*	25 to 99°C
Power requirement	117-V AC, 60 Hz

*Optional feature

in marine depth finders.

The compression and expansion of the crystalline transducers is coupled mechanically through the bottom of the pan to create the cavitation bubbles in any cleaning solution that you use. (For a complete description of the piezoelectric effect, refer to page 46 of the January 1993 *Electronics Now*).

If the cleaning solution that you select is a recognized solvent for the contaminants that you expect to find on the parts to be cleaned (for example, oil or grease), the ultrasonic cleaner will enhance the cleaning action of that solution.

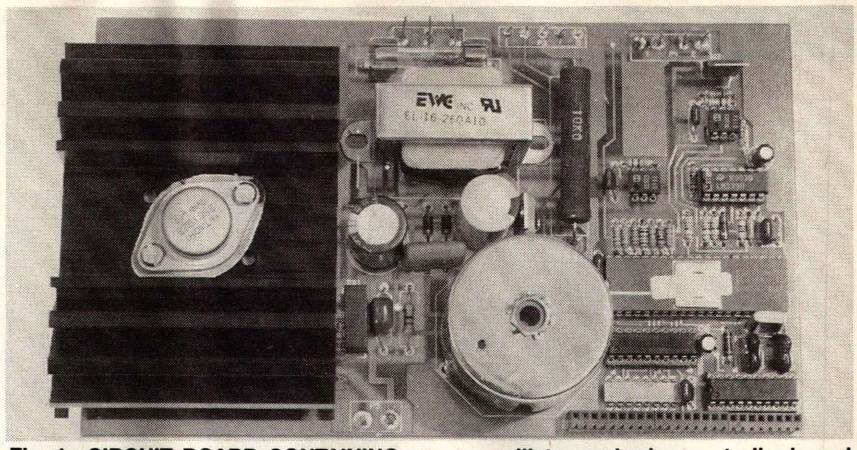


Fig. 1—CIRCUIT BOARD CONTAINING power oscillator and microcontroller-based time and temperature control circuitry.

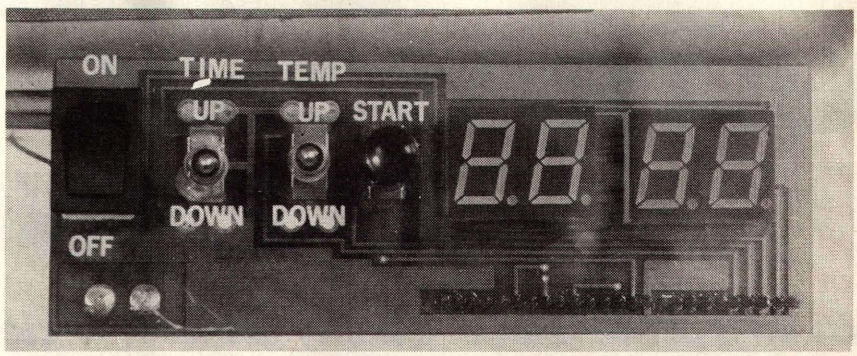


FIG. 2—CIRCUIT BOARD CONTAINING the manual operating control switches and LED time and temperature digital displays

Description of the cleaner.

The ultrasonic cleaner has three main parts: a stainless steel pan with two transducers attached, a large circuit board containing the power oscillator and time- and temperature-control circuitry, and a small switch/display circuit board containing the control switches and LED displays.

The large circuit board (approximately 5 ×8 inches) is shown in F'ig. 1. The left side of the board is occupied by the power transistor amplifier for the oscillator and its heat sink. The oscillator, made up of components on the board, supplies a 40- to 60-kHz, 1000-volt sinewave to the piezoelectric transducers. The large objects in the center of the board are the two transformers—one standard and one special. The microcontroller and other IC's are located on the right side of the board.

All of the switches are located on the smaller (approximately 2 ×5-inch) PC board shown in Fig. 2. They include, from the left, the ON-OFF power switch, the TIME UP-DOWN toggle switch, the TEMP UP-DOWN SWITCH and the START pushbutton. The green two-digit, seven-segment display on the left indicates time, and red one to its right indicates temperature.

Figure 3 shows the stainless steel cleaner pan upside down with the two piezoelectric ceramic transducers (white disks) bonded to a stainless steel plate which, in turn, is bonded to the pan bottom. The plate transmits the vibrations from the transducers more uniformly through the bottom of the pan to the cleaning solution, and it helps to protect the brittle transducers from damage that might be caused by objects accidentally dropped into the pan.

The ultrasonic cleaner will work very well without the time and temperature circuitry, but building them should be interesting, and they will add value to the cleaner. The controls will be especially useful if you plan to heat the cleaning fluid, and want to set time limits for the cleaning action on specific objects. Moreover, the controls will shut the unit off automatically.

Both time and temperature are programmable—time from from 1 to 99 minutes, and temperature from 25° to 99° C. The time and temperature functions are controlled by an Intel 8-bit CMOS 8751 microcontroller, which you can program or purchase already programmed.

Driver circuit

Refer to the right side of the two-page schematic diagram Fig. 4. The amplifier in the transducer oscillator driver is a Hitachi 2SC1922 bipolar power transistor, Q1. The oscillator tank circuit is formed by the inductance the secondary winding of transformer T1 and the effective capacitance of transducers RES1 and RES2. Bridge rectifier BR1 and capacitor C1 form a 160-volt DC power suppy operated from the 120-volt, 60-Hz line. Resistor R1 provides the base bias for Q1, through the feedback winding of T1.

As Q1 turns on, current flows through the primary of T1, which generates an opposing voltage in its feedback winding, tending to turn Q1 off again. At the parallel-resonant frequency of the tank circuit, made up of the secondary of T1, RES1 and RES2, the phase shift between the base and collector of Q1 is exactly 180°, which is necessary for circuit oscillation. The winding ratios of T1 determine the

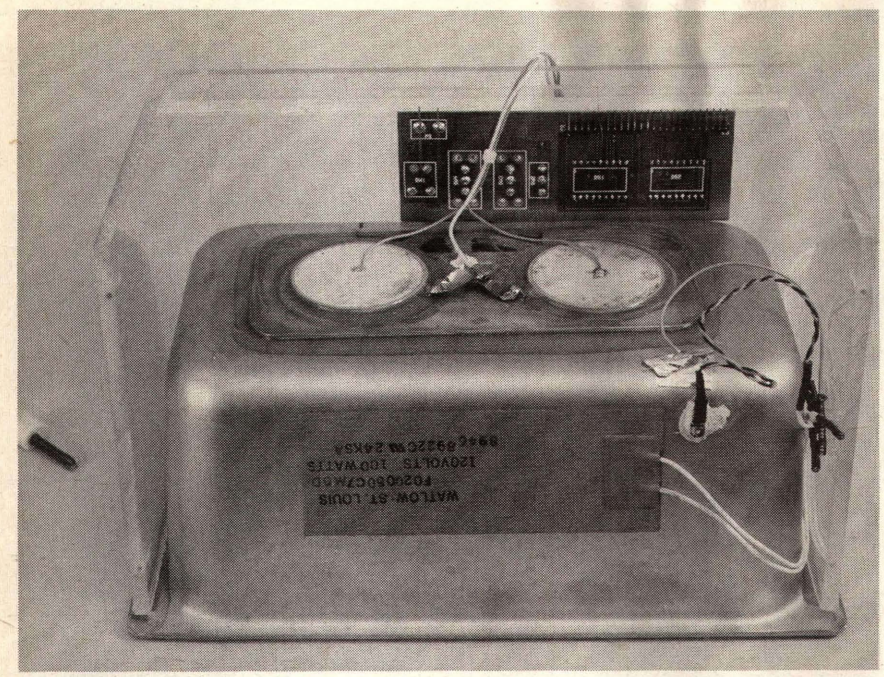
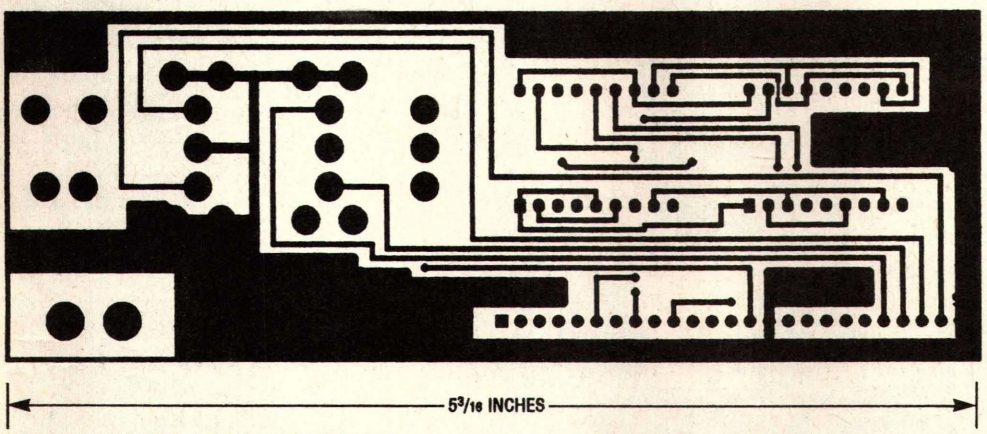
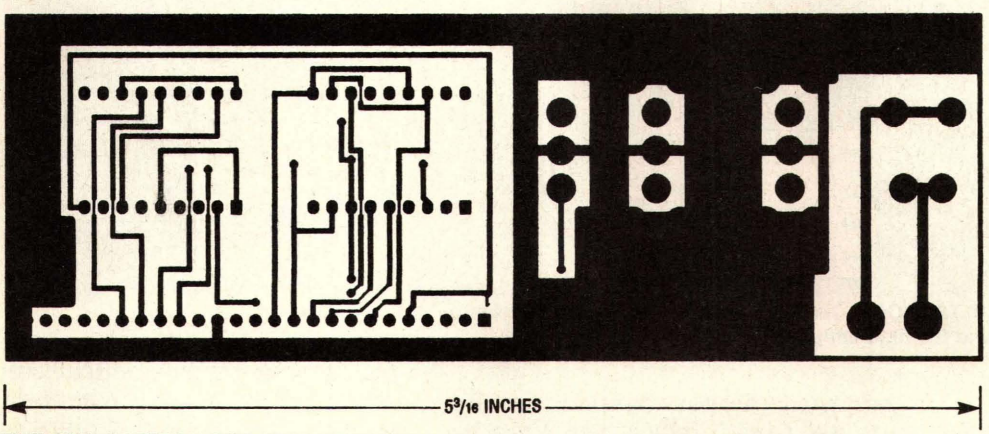


FIG. 3—VIEW OF INVERTED CLEANER PAN with two piezoelectric transducers mounted on it. The back of the control/display board is shown in the background.



THE FOIL PATTERN FOR THE FRONT (component) side of the switch/display circuit board



THE FOIL PATTERN FOR THE REVERSE (solder) side of the switch/display circuit board.

output voltage, and thus the voltage applied to the two transducers.

The input supply voltage is 160 volts DC, and the turns ratio is about 5 to 1, so the output voltage is about 1000 volts peak-to-peak. In addition, the DC startup current provided by R1 and C2 is the AC drive current for Q1. Resistor R2 and capacitor C3 supress spurious oscillations at frequencies other than the tank's primary resonant frequency.

As the drive voltage across the transducers swings through the 1000-volt peaks, the transducers expand and contract across their thickness dimensions, and their vibrations are coupled through the pan walls to the cleaning solution.

Time and temperature control

The CMOS8751 microcontroller, IC1, is the key component of both time and temperature controls. It responds to input from the START button, TIME UP-DOWN switch, TEMP UP-DOWN switch, and the temperature-sensor circuit. It provides the drive signals for the two-digit time and two-digit temperature LED displays, the transducer power Triac Q2, and the heater Triac Q3.

An assembly-code listing for the Intel 8751 firmware is available from the address given in the Parts List or from the R-E BBS (516-293-3000; 1200/2400 baud 8, N, I). The program consists of a loop, whose time corresponds to the multiplex rate of the LED displays. Each time the loop is traversed, one of the four digits is enabled; the loop rate is sufficient to eliminate display flicker. Within the loop, inputs are checked and various time, temperature, and display variables are updated. The switches provide direct input through

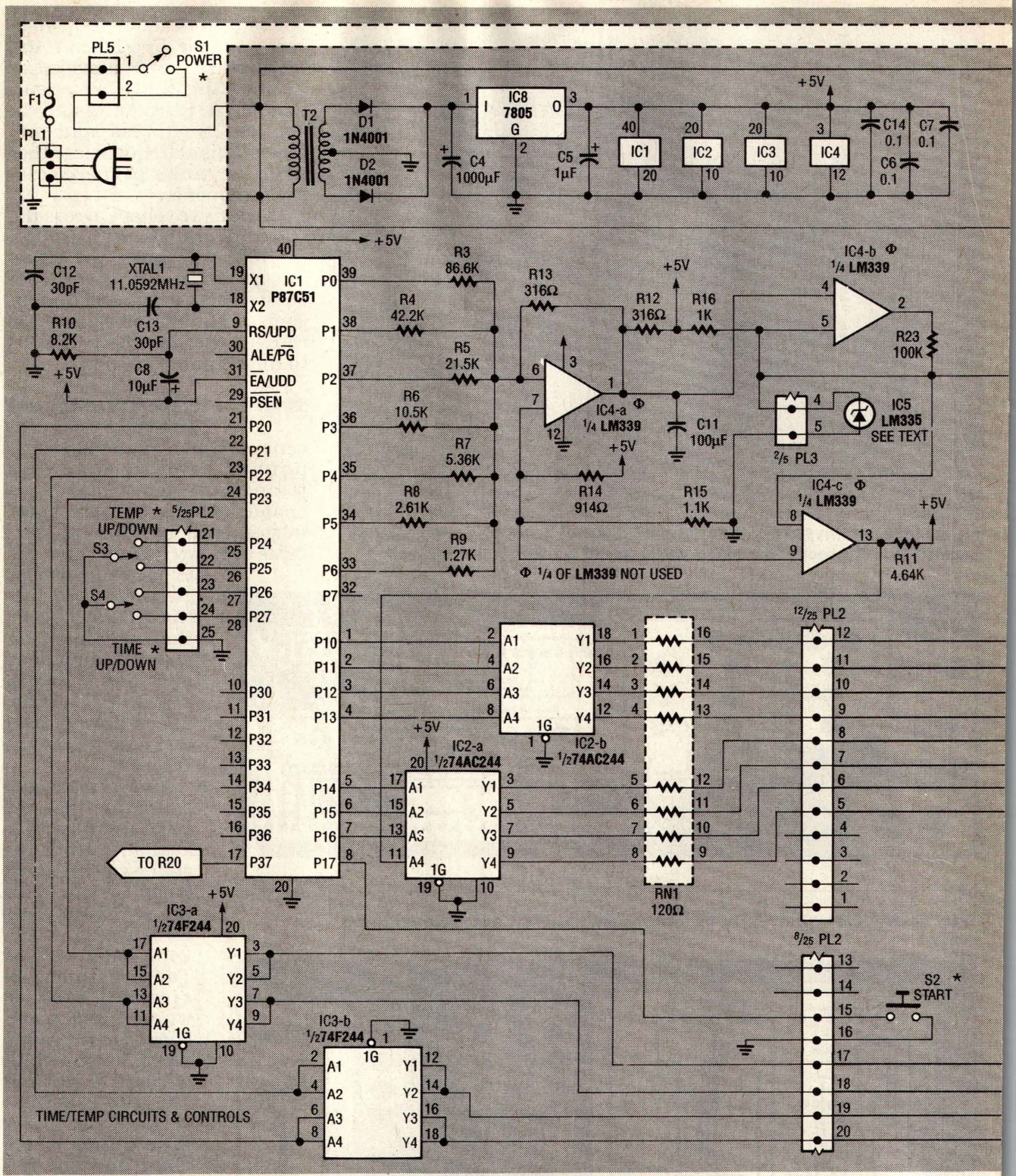
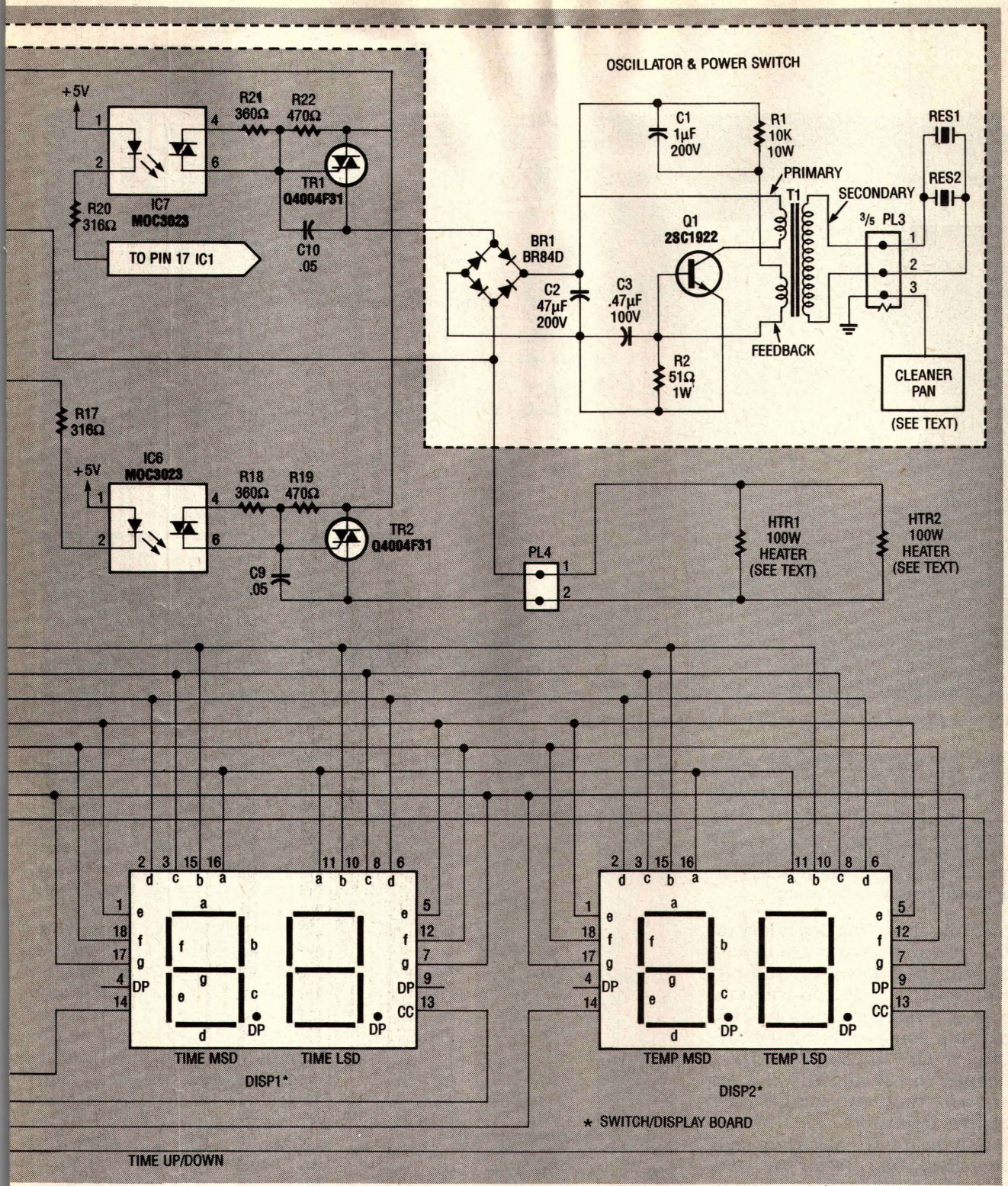


FIG. 4—SCHEMATIC FOR THE ULTRASONIC CLEANER is divided by dotted lines into the operating control section and the time-temperature control section

the I/O port.

Temperature is registered in binary format, and it is converted from a digital to an analog signal by resistor string R3 through R9 and IC4-a. This analog signal is then compared with the pan temperature signal from IC5 by IC4-b. When solution temperature falls below the selected threshold, IC6 turns on to energize Q3, which provides current to pan heaters HTR1 and HTR2. When the cleaner is first turned on, the temperature is automatically reset to 25 degrees C. Whenever heat is on, the decimal point of the temperature display LED is turned on.

The timer circuit or function depends on the internal timing capabilities of the 8751, IC1.



When the START button is pressed, Q2 is energized, powering the transducers. The internally registered time is decremented and displayed, and when zero time is reached, Q2 is turned off and the original time is reset. When the cleaner is turned on, the time is set automatically to 5 minutes, but this setting can be adjusted up or down.

Finally, multiplexed segment and digit drive is provided to the displays by IC2, IC3, and current is limited by the eight 120-ohm resistors in network RN1. Power for the control section is provided by T2, D1, D2, and 5-volt regulator IC8. Further details of the firmware operation can be found by reading the code comments.

Circuit board assembly

Refer to Fig. 4, the two-page schematic for the complete ul-

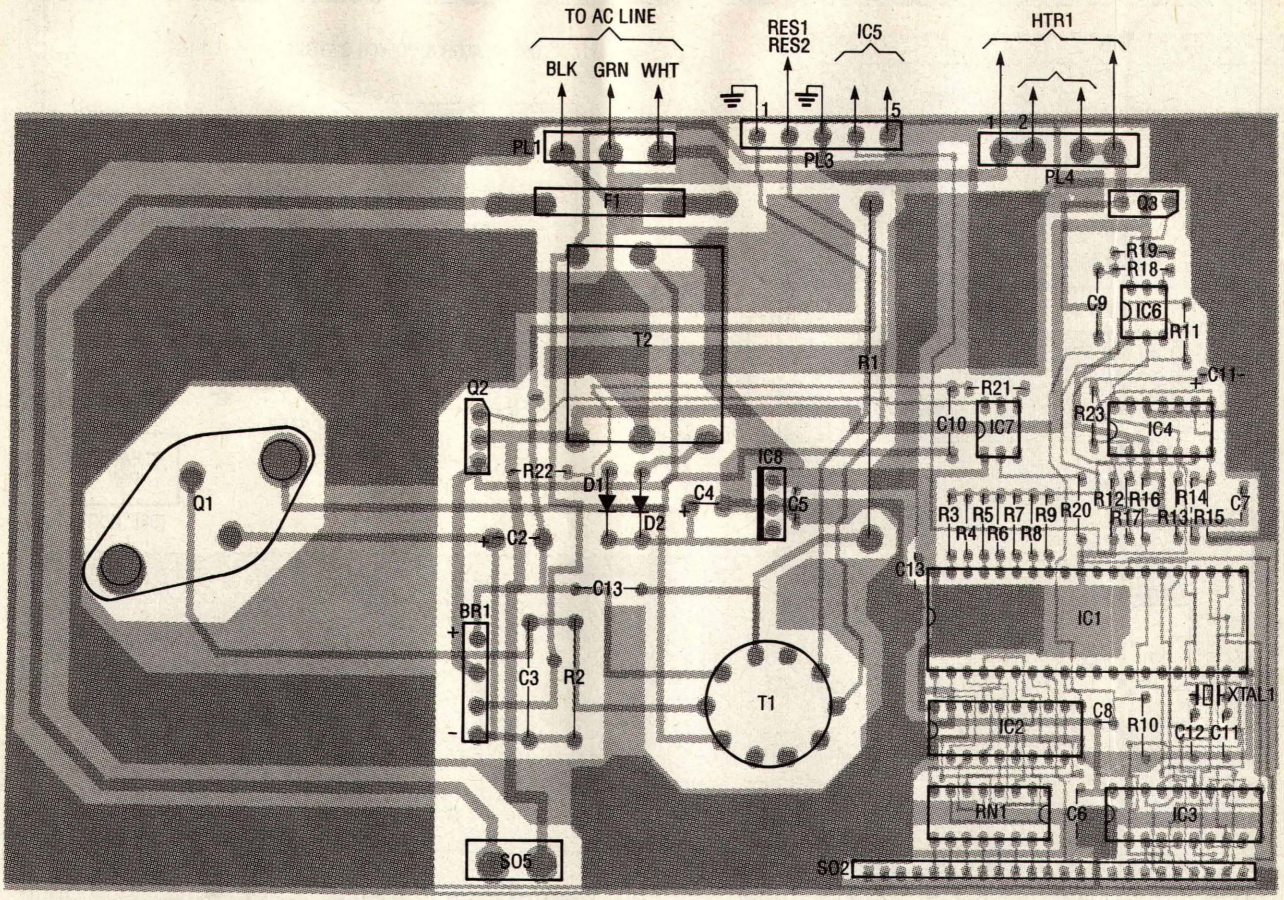


FIG. 5—PARTS PLACEMENT DIAGRAM for large circuit board.

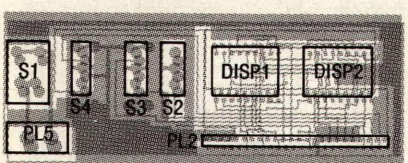


FIG.6—PARTS PLACEMENT DIAGRAM for switch/display circuit board.

trasonic cleaner. A boundary on the schematic separates the oscillator and power switch circuit from the time and temperature circuits and controls. This permits you to distinguish between the basic circuitry needed to operate the cleaner and the time and temperature control circuitry.

Note that both circuit boards are two-sided. Foils for the parts placement and solder sides of both boards are included here. Making these boards might prove to be a challenge if you have not had much experience fabricating printed circuit boards of this complexity. Therefore, both boards complete with solder masks and through-hole plating are offered in the Parts List.

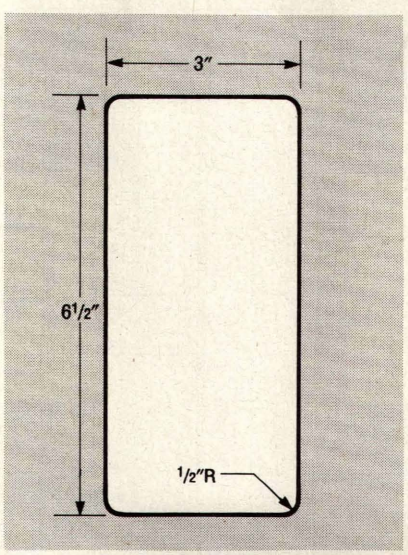


FIG. 7—OUTLINE FOR THE TRANSDUCER MOUNTING PLATE to be cut from 0.063-inch stainless steel plate.

Refer to Fig. 5, the parts placement diagram for the large board circuit board. The order of component placement on this circuit board is not critical—whether or not you plan to include the time/temperature circuitry and control switches. The only component on that board not available as a standard catalog item is transformer T1. You can purchase transformer T1 from the same source given in the Parts List or you can wind your own if you choose to do so.

If you choose to wind your own transformer T1, it will be necessary for you to obtain a ferrite core and Litz wire. The core in the prototype is a Ferroxcube 4229-PA275 ferrite core obtainable from Philips Components Discrete Products, Saugerties, NY 12477. The primary winding has 20 turns of 21 strand/36 AWG Litz wire and the secondary has 99 turns of the same wire. Feedback is obtained with 3½ turns of No. 22 AWG wire.

Be sure to double check the values of all the components as you insert them. Power transistor Q1 is positioned on top of the heatsink as shown in Fig. 1, and both parts are fastened to the board with screws at the same time. Insulate Q1 from the

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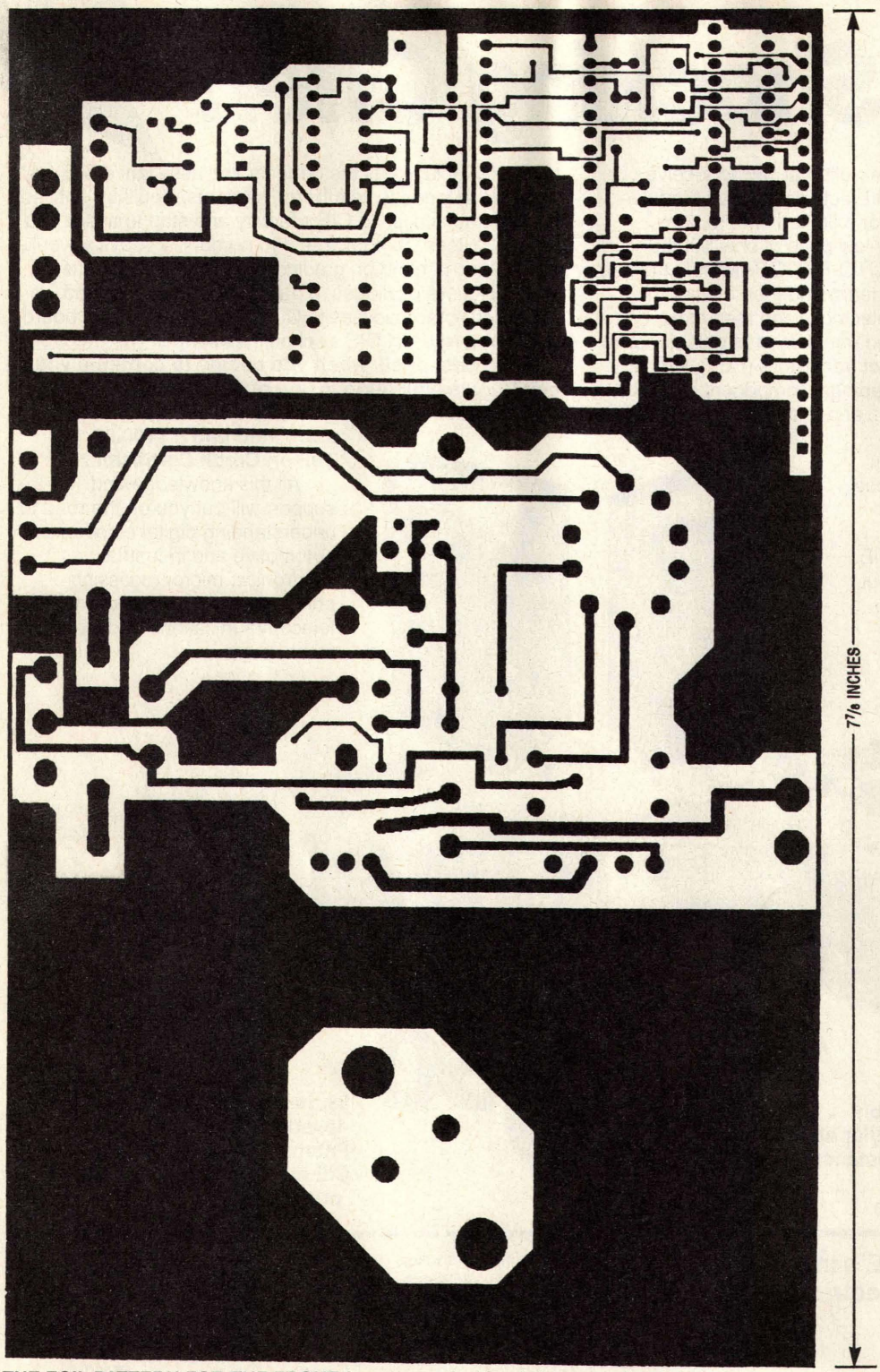


THE FOIL PATTERN FOR THE FRONT (component) side of the main circuit board

heatsink with a mica insulator coated liberally with heatsink grease. After mounting Q1, check its isolation with a meter to be sure that it really is insulated from the other components or conductors.

Mount transformer T1 by the lugs on its frame and connect its wires individually as indicated in Fig. 4. If you plan to build the cleaner without the time and temperature controls, the positions for those components will remain open. The precision temperature sensor, LM355, (IC5) will be epoxied on the bottom of the stainless steel pan, and be connected to the board by a twisted pair of wires at P3.

Sockets are recommended for all DIP-style IC's (IC1, IC2, IC3, IC4, IC6, IC7), particularly the microcontroller, IC1. Insert all resistors, capacitors, plugs (three-pin plug, PL1; five-pin plug, PL3; and four-pin plug, PL4), sockets (25-pin socket SO2 and two-pin socket SO5, resistor network, rectifier bridge, Triacs and diodes. Solder all leads and trim excess lead lengths. Examine the circuit board closely to be sure there are no accidental solder bridges or cold joints.

Refer to the parts positioning diagram, Fig. 6, and insert the three switches (S1–S3), the sockets for the two dual-digit, segmented LED displays, DISP1 and DISP2, and the right-angle, 25-pin header PL2. Solder all leads and trim excess. Again, check for inadvertent solder bridges or cold solder joints before inserting the displays.

Transducer plate and tank

Start the assembly of the tank and transducers by cutting out a +3 ×6½-inch rectangle from 0.062-inch stainless steel plate as shown in Fig. 7. Round the corners to ½-inch radiuses, deburr all edges, and sand or grind both sides so the plate will lie flush against the bottom of the stainless steel tray.

Next, prepare both trans-

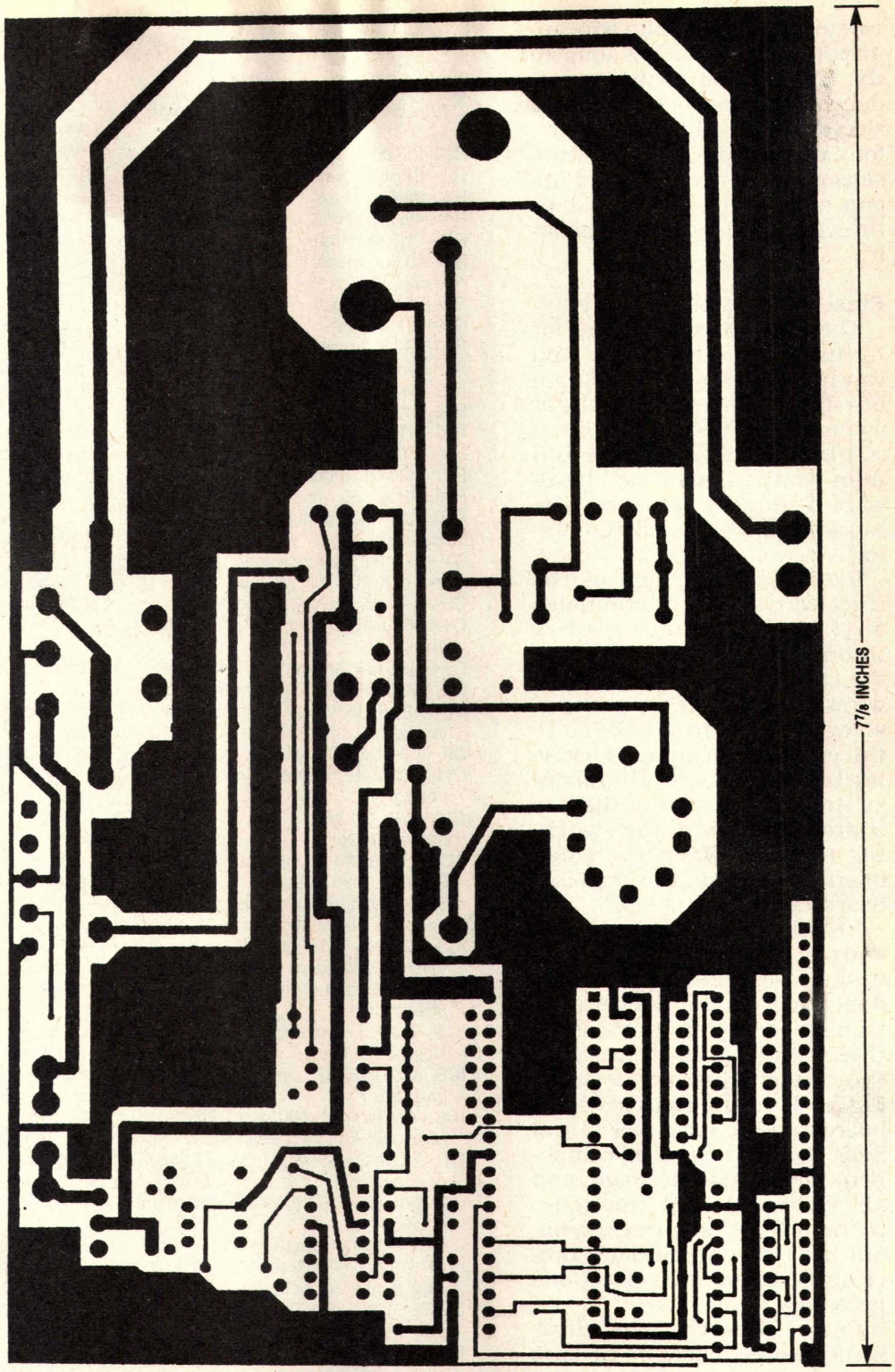
ducers, RES1 and RES2, for wire attachment by cleaning their surfaces with alcohol or other suitable solvent. Strip about ¼-inch of insulation from both ends of a pair of 24 to 26 AWG multistrand hookup wires approximately 12 inches long for transducer connection. Flatten the wires by fanning out their stranded ends, and tin the strands with lead-tin solder.

Carefully solder the fanned out strands of one wire to the centers of each transducer as rapidly as possible to prevent overheating and damaging the ceramic transducer. Then solder a copper wire, approximately 3 inches long to connect the reverse sides of the transducers, observing the same precautions about soldering.

Note: *the transducers are polarized, and both must have the same polarity on top and on the bottom.* If this is not observed, the opposing vibrations of each transducer will cancel the effect of the other one.

After the wires are soldered to the transducers, the next step is to bond the transducers to the rectangular transducer mounting plate. Refer to Figs. 3 and 8 to see how the transducers are positioned on the plate. Mix the two parts of a high quality, slow-setting epoxy and apply a film of it to the plate. Position the transducers on the plate, and while applying slight pressure, rotate them slightly so that some epoxy underneath the transducers is squeezed out to form a bead of epoxy around the edges of the transducers where they contact the plate.

When the epoxy holding the transducers has set, apply epoxy to the transducer plate assembly and cement it to the bottom of the tank, also as shown in Figs. 3 and 8. If you intend to include the optional temperature control, adhere the two heating elements, HTR1 and HTR2, to the sides of the pan (one is shown in Fig. 3.) Solder or crimp sleeves to the ends of the heater wires. Solder a



THE FOIL PATTERN FOR THE REVERSE (solder) side of the main circuit board

twisted pair of hook-up wire approximately 12 inches long to the LM335 temperature transducer (IC5) and solder or crimp sleeves to the other ends of the four wires. Epoxy temperature sensor IC5 to the bottom of the pan as shown in Fig. 8. Mark the wires to identify their polarity.

Final wiring and assembly

There are no requirements for the ultrasonic cleaner case. You can make one by assembling a box from ¼-inch sheet plastic or you can purchase a small 6 × 6 × 9-inch plastic storage bin from your neighborhood hardware or houseware store. The bin will work very well as a protective case.

Pass the bare ends of the three-wire line cord terminated with a three-prong plug through the grommeted hole in the case. Strip the ends of the wires for soldered or crimped sleeves to connect them to three-pronged plug PL1, observing the ground wire. The ON-OFF switch on the switch-display board will perform the switching function when the small board is plugged into the large board through plug PL5.

Install fuse F1 in its holder, and place the large circuit board in the case. Connect the transducer, heater, and temperature transducer wires by pressing their terminating sleeves over the header pins as shown in Fig. 8. Plug the switch/display board into the sockets SO2 and SO5. Carefully check all component values and placement, and all wiring against the schematic, Fig. 4, before carrying out the test and checkout procedures. Make any corrections necessary.

Before operating the ultrasonic cleaner, check to be sure that the pan is grounded to the line cord ground and the primary of transformer T1 is isolated from its secondary and tank circuit.

Test and checkout procedure

Temporarily support the tank next to the circuit board. Fill the pan at least half full with water. *Caution—Never operate the cleaner unless the pan is at least half full of liquid.* Apply power, and turn on the cleaner. You should hear a hissing sound from the pan and you should be able to feel the vibrations with your fingertips on the edge of the pan. If you do not hear or feel these operating indications, check for the presence of the primary 160 volts at C1, and +5 volts at C5.

When testing, remember that the primary circuit is connected

PARTS LIST

All resistors are ¼-watt, metalized film, 5 % unless otherwise stated.

R1—10,000 ohms, wirewound, 10 watt
R2—51 ohms, wirewound, 1 watt
R3—86,600 ohms
R4—42,200 ohms
R5—21,500 ohms
R6—10,500 ohms
R7—5300 ohms
R8—2610 ohms
R9—1270 ohms
R10—8200 ohms
R11—4640 ohms
R12, R13—316 ohms
R14—914 ohms
R15—1100 ohms
R16—1000 ohms
R17, R20—316 ohms
R18, R21—360 ohms
R19, R22—470 ohms

Capacitors

C1—1μF, 200 volt, polyester film
C2—47μF, 200 volt, polyester film
C3—0.47μF, 100 volt, polyester film
C4—1000μF, 15 volt, aluminum electrolytic
C5—1μF, 15 volts, aluminum electrolytic
C6, C7, C14—0.1μF, polyester film
C8—10μF, 15 volts, aluminum electrolytic
C9, C10—0.05μF, polyester film
C11—100muF, 15 volt, aluminum electrolytic
C12, C13—30 pF

Semiconductors

IC1—87C51 CMOS microcontroller with EPROM, Intel or equiv.
IC2—74AC244PC octal bus driver, non-inverting, National or equiv.
IC3—74F244 octal bus driver, non-inverting, National or equiv.
IC4—LM339 quad comparator, National or equiv.
IC5—LM335 temperature transducer, National or equiv.
IC6, IC7—GE3023 optoisolator, Harris or equiv.
IC8—LM340TS (7805) voltage regulator, 1A, Motorola or equiv.
Q1—2SC1922 power transistor, Hitachi or equiv.
Q2, Q3—triac, Teccor Q4004F31 or equiv.
D1, D2—1N4001 silicon diode
DISP1—LN526GA 7-segment LED display, Panasonic or equiv.
DISP2—LN526RA 7-segment LED display, Panasonic or equiv.
BR1—BR840, full wave rectifier bridge, Diodes Inc. or equiv.
RN1—eight 120 ohm resistor network, CTS9043 or equiv.

Other component

F1—fuse, 6 ampere, standard
HTR1, HTR2—100 watts, 120 volts, Watlow FO20050C7 or equivalent
S1—switch, rocker, panel-mounted
S2—switch, miniature toggle, momentary SPST, panel-mounted
S3, S4—switch, miniature toggle, momentary SPDT, panel-mounted
XTAL1—11.0592 MHz crystal holder
T1—transformer, custom wound (see text)
T2—transformer, EWC Inc. EL-16-260A10 or equiv.
P1—three-pin header
P2—25-pin right-angle header
P3—five-pin header
P4—four-pin header
P5—two-pin header
SO2—25-pin socket
SO2—2-pin socket
RES1, RES2—piezoelectric transducers, ceramic, 2-inch, Vernitron 56786 PZT-4 or equiv.

Miscellaneous: large and small circuit boards, stainless steel tank (6⅞ × 4¼ × 4 inches, Polarware No.E904 or equiv.), Anodized aluminum heat sink, (4 × 3 × 2 inches), transducer mounting plate (see text), mica insulator for a bipolar power transistor, thermal conductive grease, sockets for IC1, IC2, IC3, IC4, IC5, IC6, IC7, three-wire power cord with 3-prong plug, line cord grommet, fuse holder, case (see text), hookup wire, wire sockets, epoxy, solder.

Note: The following parts are available from A&T Labs, P.O. Box 4884, Wheaton, IL 60187:

- Kit of parts for the ultrasonic cleaner without time and temperature controls/displays or case, $169.00.
- Kit of all parts for the complete ultrasonic cleaner including programmed 8751 microcontroller except case, $249.00
- Double-sided printed circuit boards—large, $25.00; small, $9.00
- Programmed Intel 8751 microcontroller, $29.00
- Custom-wound transformer T1, $69.00
- Ceramic piezoelectric transducers RES1 and RES2, $32.00
- Stainless steel cleaner pan, $19.00

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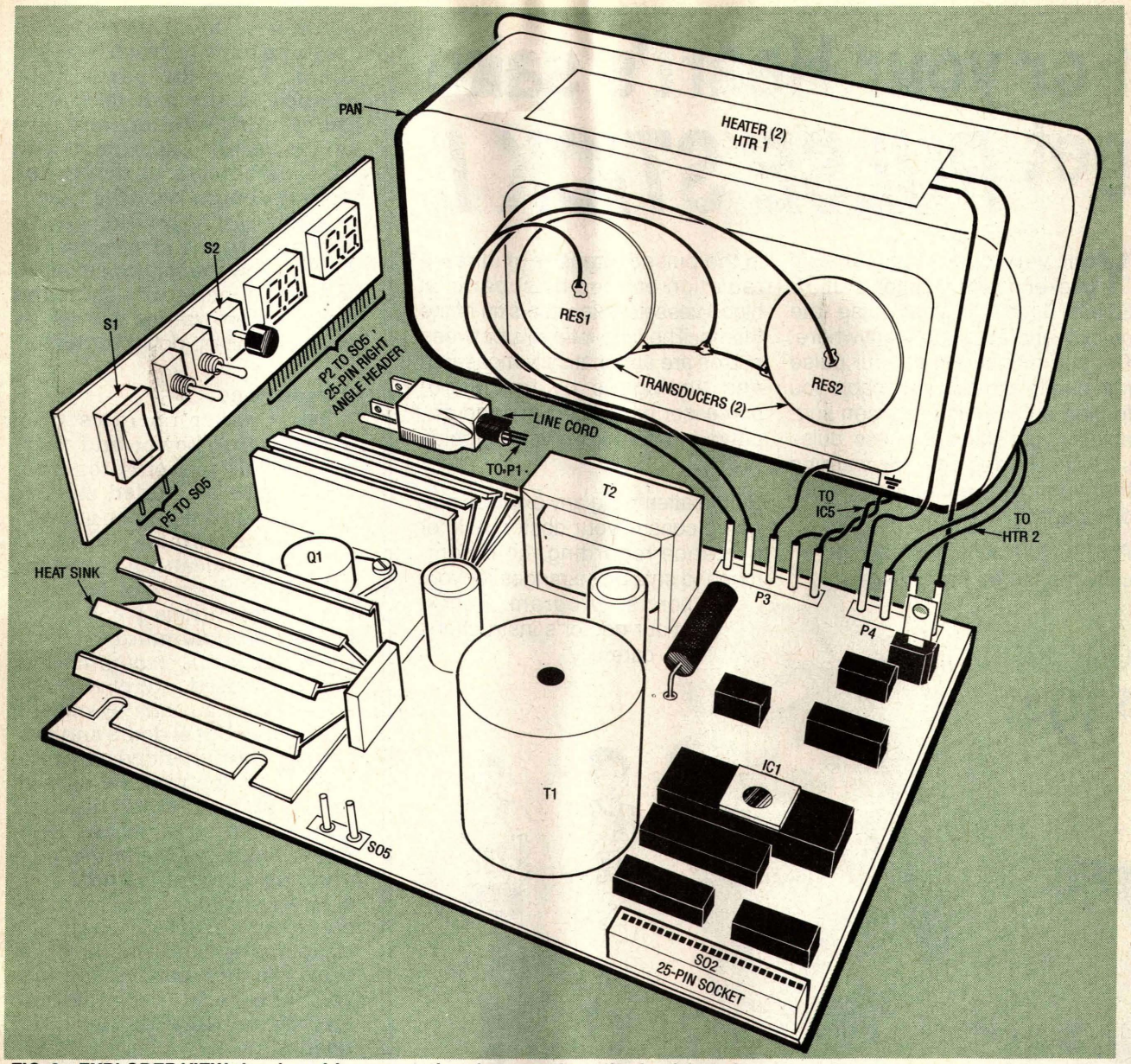

FIG. 8—EXPLODED VIEW showing wiring connections between the main circuit board to the piezoelectric transducers, pan heaters, and temperature sensors mounted on the pan.

to the 120-volt power line, so exercise caution to avoid electric shock. Also, the voltage applied to the transducers is about 1000 volts. If the unit fails to function at turn-on, check for the presence of 11 MHz at pin 18 of the microcontroller IC1, and look for changes in the time and temperature display LED's. At turn-on, those digital displays should readout 5 and 25, respectively.

Although the design frequency should be close to optimal, further adjustment could improve efficiency. Perform any additional tuning by turning the slug core of transformer T1. Adjust it gradually until you are able to observe maximum turbulence in the cleaning fluid. One way to determine a maximum is by adding a drop of food coloring to the water, and adjusting for maximum dispersion rate of the color in solution.

Cleaner operation

You can purchase cleaning fluids from hardware, auto parts, and grocery stores, but you can also easily mix your own. You might want to experiment with cleaning mixtures. A general rule of thumb is that any cleaning solution that works satisfactorily in cleaning objects by hand methods will also work in the ultrasonic cleaner. Liquid detergent in water, for example, is a good general cleaner, while ammonia in water works well for jewelry. Carburetor cleaner cleans carburetors and other automotive, bicycle or machine parts that are coated with oily or greasy contaminants.

Before cleaning any object in the ultrasonic cleaner, it is a good idea to remove as much surface dirt and grime as possible manually with paper towels, brushes, or cotton rags to minimize the contamination entering the cleaning solution. The

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cleaner is most effective in cleaning hard-to-reach recessed areas. Place the parts to be cleaned in the pan filled with the cleaning solution, and turn on the cleaner. Experiment with various objects to determine their optimum cleaning time.

If the cleaning solution is to be heated, turn the main power on first to allow the solution to reach its set temperature. Time and temperature values are set by pushing the up/down buttons.

Precautions

The cleaner operates from 120-volt line power and there are liquids present; together these pose an added electric shock hazard if proper grounding is not maintained. Moreover, some cleaning solutions and their vapors can be toxic. Other precautions are:

- *The use of flammable cleaning fluids is not recommended.* If they are used, exercise all reasonable precautions by moving the cleaner out of doors and never leave it unattended while the fluid is in the pan. Be sure to return all toxic fluids to a safe storage container when cleaning is complete. *Never use gasoline as a cleaning fluid!*
- Never put your hands into the cleaning solution when the cleaner is on. The intense vibrations can drive particulates into your skin, and the ultrasonic energy could damage body tissues.
- Minimize any time spent close to the operating cleaner because the high-frequency 40-kHz oscillations can cause headaches and might lead to hearing impairment although they are not audible.
- Be sure that the pan is at least half filled with solution during all cleaning operations.
- Place any objects to be cleaned carefully in the pan with tongs, and take care not to drop any heavy object in the pan that could damage the fragile transducers.
- The use of chlorofluorocarbon (CFC) solvents, commonly used to remove solder paste from circuit boards, is not recommended because of their threat to the environment. Ω

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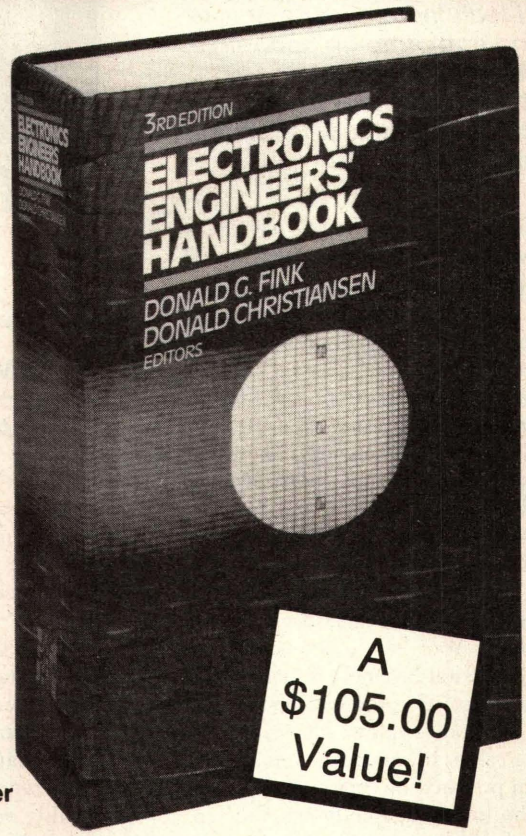

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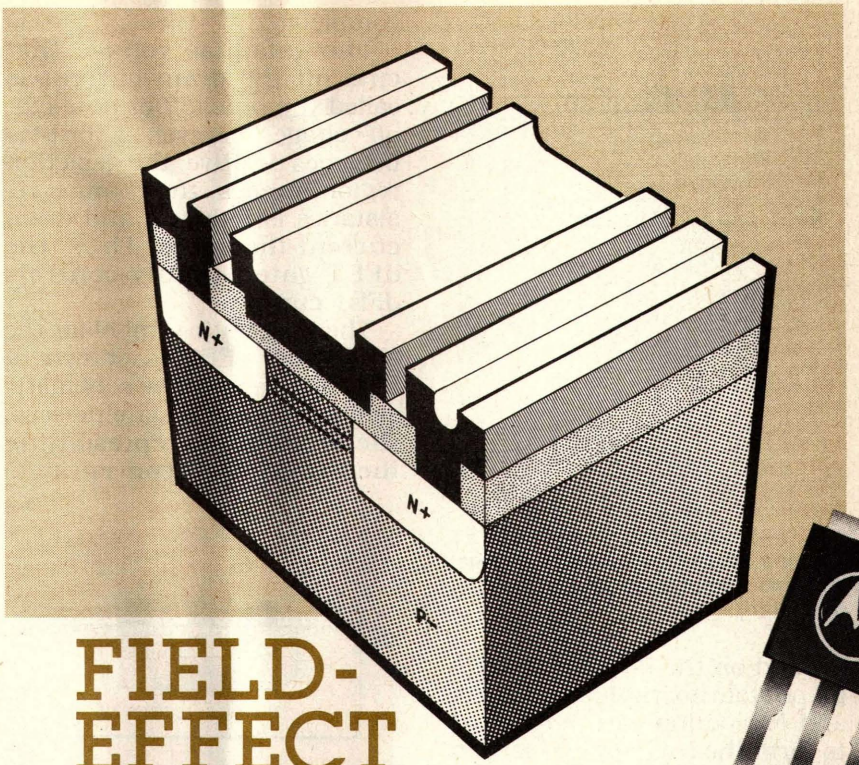
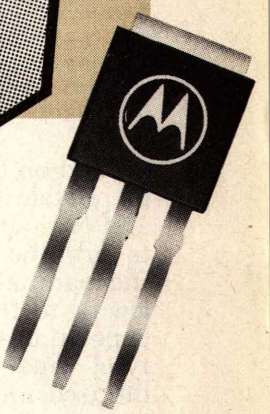


FIELD-EFFECT TRANSISTORS



Learn about field-effect transistors: JFET's, MOSFET's, DMOS MOSFET's and CMOS—how they are made, how they work, and what to look for when selecting them for your designs.

FIELD-EFFECT TRANSISTORS (FET'S) are unipolar rather than bipolar devices, and this gives them certain properties that are superior to those of bipolar transistors. Unlike the bipolar transistor, whose current depends on the movement of both electrons and holes, FET operation depends on only one of those charge carriers. Freed from the time delays that occur when those charge carrier recombine, FET's offer faster switching speed and higher cutoff frequencies.

Other advantages of the FET include:

- Voltage rather than current operation.
- Extremely high input impedance in the OFF state.
- Virtually constant current with respect to voltage at specific bias levels.
- Current change that is inversely rather than directly proportional to temperature.

Despite these advantages, the FET has not replaced the bipolar the bipolar transistor in all applications, but it has encouraged new generations of small-signal and general purpose and RF MOSFET's as well as general purpose and RF MOSFET power transistors. Moreover, the latest digital logic families are based on FET technologies. The basic FET is a simple, three-terminal, voltage-controlled device with characteristics that are similar to those of vacuum-tube pentodes. Thus, the FET is considered to be the solid-state equivalent of a pentode.

The two major classes of FET's are the *junction* FET (JFET) and *metal-oxide-semiconductor* FET (MOSFET), formerly called an *insulated-gate* FET (IGFET). FET's are further divided into *N-channel*, *P-channel*, *depletion-mode* and *enhancement-mode* devices. MOSFET's with N-doped channels are called NMOS, and those with P-doped channels are referred to as PMOS.

The three electrodes in all FET's are the *source*, *drain*, and *gate*, analogous to the emitter, collector, and base of the bipolar transistor. Both JFET's and MOSFET's are available as discrete transistors. Some MOSFET's have dual gates and are intended for use as radio-frequency mixers.

This article explains how P-channel and N-channel MOSFET's are combined to form the popular complementary-MOS (CMOS) digital logic families. CMOS technology has made possible very large scale integrated (VLSI) memories, microprocessors and dedicated circuits that contain more than one million transistors and still have very low power requirements.

Most small-signal FET's today are fabricated with *planar* geometry in which all electrodes are accessible from the top of the device. The active regions are defined on the wafer or substrate by successive masking, etching, and deposition or ion-implantation steps. But power MOSFET's now being fabricated with vertical structures are actually capable of handling much higher current in smaller areas of silicon.

Junction FET's

The simplest FET, the JFET, is illustrated by the cross-section view of Fig. 1-a. It is made by selectively implanting or diffusing ions into the wafer or substrate. An N-type region is

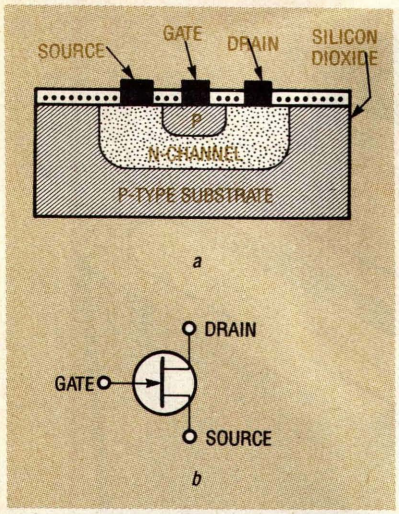


FIG. 1—N-CHANNEL PLANAR JFET showing diffused or implanted channel and gate regions (*a*), and schematic symbol (*b*).

defined on the P-type substrate by photolithographic methods, and N-type ions are implanted to form the N-channel. Later in the manufacturing process, following further masking, oxide-deposition and etching steps, P-type ions are implanted or diffused into the N-channel to form the P-type gate.

Aluminum source and drain terminals are formed directly on the N-channel and an aluminum gate terminal is formed on the P-type gate. The symmetrical construction of the JFET permits the drain and source to be interchanged, if necessary.

If a positive voltage is applied at the drain of the N-channel JFET shown in Fig. 1-a, and a negative voltage is applied at the source with the gate terminal open, a drain current flows. When the gate is biased negative with respect to the source, the PN junction is reverse biased, and a *depletion region*, devoid of current carriers, is formed.

Because the N-channel is more lightly doped than the P-type gate material, the depletion region penetrates into the N-channel. This region, depleted of charge carriers, behaves like an insulator. The depletion region narrows the N-channel and increases its resistance. If the gate bias is made even more negative, drain current is cut off completely.

The gate-bias voltage that cuts off the drain current is called the *pinchoff* or *gate-cutoff* voltage. However, as the bias becomes positive, the depletion region recedes, the channel resistance is reduced, and drain current increases. Thus, the JFET gate actually controls JFET current.

The schematic symbol for the N-channel JFET is shown in Fig. 1-b. As in other schematic symbols for solid-state devices, the arrowhead (representing the direction of conventional current flow) points from P-doped material to N-doped material. In the N-channel JFET symbol, the arrowhead points from the P-type gate toward the N-type channel.

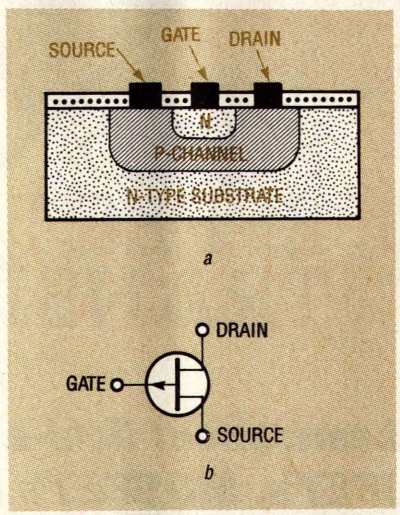


FIG. 2—P-CHANNEL PLANAR JFET showing diffused or implanted channel and gate regions (*a*), and schematic symbol (*b*).

A section view of a P-channel JFET is shown in Fig. 2-a. The channel of the device is P-type material, and the gate is N-type. If a positive voltage is applied to the source, conventional current flows from the source to the drain. To reverse bias the junction between the N-type gate and the P-type channel, the gate must be made positive with respect to the channel. The biasing voltages of a P-channel JFET are opposite to those of the N-channel JFET.

The schematic symbol for the P-channel JFET is shown in Fig. 2-b. The arrowhead also points from P-type material to N-type material. In this instance, it points from the P-type channel to the N-type gate region. The characteristics of the P-channel JFET are similar to those of the N-channel device, except that the voltage and current polarities are reversed.

Both N-type and P-type JFET's operate in the *depletion* mode; that is, they conduct with zero bias on their gates. Figure 3 shows a typical family of *drain characteristics* for an N-channel JFET. As the gate-to-

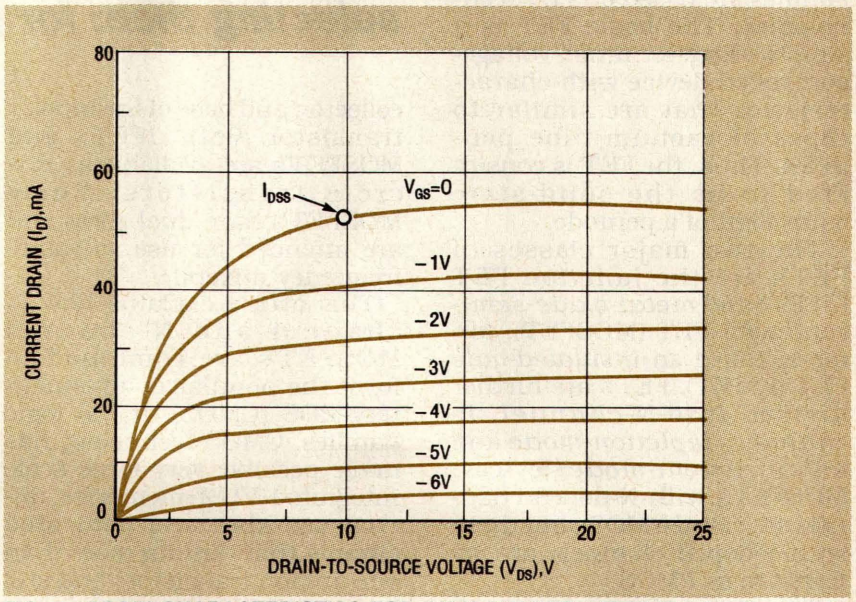


FIG. 3—DRAIN CHARACTERISTICS FOR AN N-CHANNEL JFET. The family of gate curves has its origin at zero drain-to-source volts, and the gate bias values show voltage control.

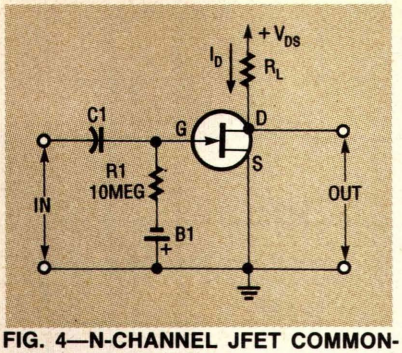


FIG. 4—N-CHANNEL JFET COMMON-source amplifier is analogous to a bipolar common-emitter amplifier.

source voltage is made increasingly negative, the depletion region is increased, and drain current decreases. As a result, pinchoff voltage occurs at a lower value of V_{DS}. Curves for different values of gate-to-source bias, V_{GS}, are plotted in the figure because the FET is a voltage-operated device.

JFET circuits

When an N-channel JFET is connected to a V_{DS} supply as shown in Fig. 4, a drain current, I_D, flows in the device. The magnitude of I_D can be controlled by a gate-to-source bias voltage, V_{GS}. Similarly, when a P-channel JFET is connected to a negative drain voltage, a drain current, I_D, flows in the device. The value of I_D is maximum when V_{GS} equals zero, and it is reduced (to bring the JFET into a linear operating region) by applying a reverse bias to the gate terminal of the device (negative bias in a N-channel device, positive bias in a P-type).

In Fig. 3, the value of V_{GS} to reduce I_D to zero, the gate-to-source pinchoff voltage V_P is about -7 volts. The value of I_D when V_{GS} equals zero (called I_{DSS} or drain saturation current for zero bias) is about 52 milliamperes for the device shown in the figure.

The gate-to-source junction of the JFET has the characteristics of a silicon diode. When reverse biased (to bring it into its linear operating region), gate leakage currents (I_{GSS}) are measured in thousandths of a microammpere at room temperature. Actual gate signal currents are only a fraction of a that, and the input impedance to the gate is typically 1000 megohms at low frequencies. The gate junction is effectively shunted by a capacitance of a few picofarads, so input impedance falls as input frequency is increased.

If the gate-to-source junction of the JFET is forward biased, it conducts like a normal silicon diode, and if it is severely reverse biased it avalanches like a Zener diode. Neither of those conditions will harm a JFET if its gate currents are limited to those specified.

Referring to the N-channel JFET drain characteristics in Fig. 3, it can be seen that, for each value of V_{GS}, drain current I_D rises linearly from zero as the

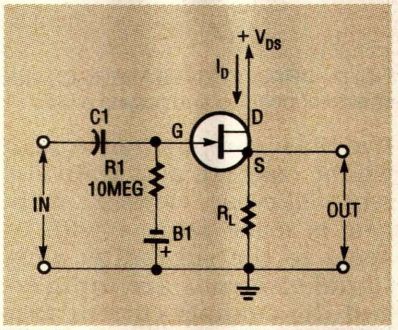


FIG. 5—N-CHANNEL JFET COMMON-drain (source-follower) amplifier is analogous to a bipolar emitter-follower amplifier.

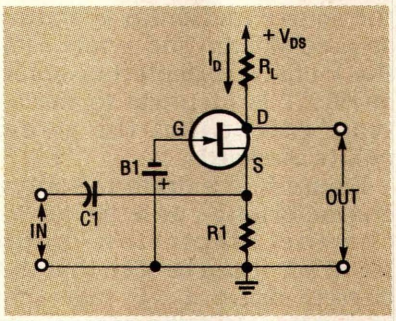


FIG. 6—N-CHANNEL JFET COMMON-gate amplifier is analogous to a bipolar common-base amplifier.

drain-to-source voltage (V_{DS}) is increased from zero to a value at which a *knee* occurs on each curve. Moreover, I_D remains virtually constant as V_{DS} is increased beyond where the knee occurs.

Thus, when V_{DS} for any of the family of V_{GS} curves is below its knee value, the drain-to-source

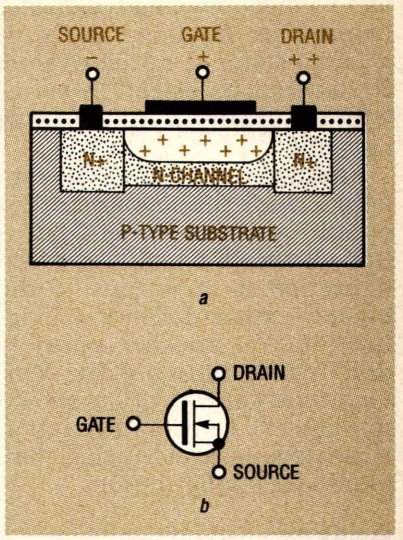


FIG. 7—N-CHANNEL, DEPLETION-mode MOSFET with negative gate bias (*a*), and schematic symbol (b).

pins of the JFET act like a voltage-variable resistor with its value determined by V_{GS}. The drain-to-source resistance, R_{DS}, can be varied from several hundred ohms at V_{GS} = zero to thousands of megohms at pinchoff. That characteristic permits the JFET to be used in a circuit as a voltage-controlled switch.

From the drain characteristic curve of Fig. 3, it can be seen that when V_{DS} is above the knee value, the I_D value is dictated primarily by the V_{GS} value, and is virtually independent of the V_{DS} value. This characteristic permits the JFET to function as a voltage-controlled current generator.

The *gain* of a JFET is specified as a *transconductance*, g_m, the rate of change of drain current with respect to gate voltage. A g_m of 5 milliamperes per volt indicates that a variation of one volt on the gate produces a change of 5 milliamperes I_D. The units of this measurement are in inverse ohms or *mhos*. You will find that JFET data sheets usually specify g_m in millimhos or micromhos.

The N-channel JFET in Fig. 4 is organized as a common-source amplifier, analogous to a bipolar NPN common-emitter amplifier. In typical applications, the JFET is biased into its linear region and organized

as a voltage-to-voltage converter or amplifier. As shown in Fig. 4, a load resistor of suitable value, R_L, should be placed in series with the JFET's drain-to-source current.

Another common JFET configuration is the *common drain* or *source-follower* configuration shown in Fig. 5. That configuration is analogous to the bipolar emitter-follower configuration. Yet another possible JFET configuration is the *common-gate* configuration shown in Figure 6. That configuration is analogous to a bipolar common-base configuration.

MOSFET's explained

The metal-oxide FET or MOSFET was developed as an improvement on the JFET, and it has become the most important form of FET. Figure 7-a illustrates an N-channel depletion-mode MOSFET with a negative gate bias. The gate of this MOSFET is fully insulated from the adjacent channel. This is the most important distinction between an N-type depletion-mode MOSFET and an N-type JFET, which is manufactured with a doped gate region directly under and in contact with the gate.

The surface of the silicon P-type wafer is first coated with a layer of silicon dioxide (SiO_2), and the source and drain windows are masked and etched to expose the P-type substrate. N-dopants are heavily diffused or implanted into those two regions. Another window is masked and etched over the channel, and it is given a lighter concentration of N dopant. In subsequent steps, the channel is recoated with an insulating oxide, and the metal source, drain, and gate terminals are deposited.

When the drain is positive with respect to the source, a drain current will flow, even with zero gate voltage. However, if the gate is made negative with respect to the substrate, positive charge carriers (holes) induced in the N-channel will combine with the electrons and cause channel resistance to increase. With increasing negative bias, the pinchoff voltage will be reached, and drain current will cease. However, if the gate is made positive with respect to the substrate, additional electrons are induced, and the channel current then increases.

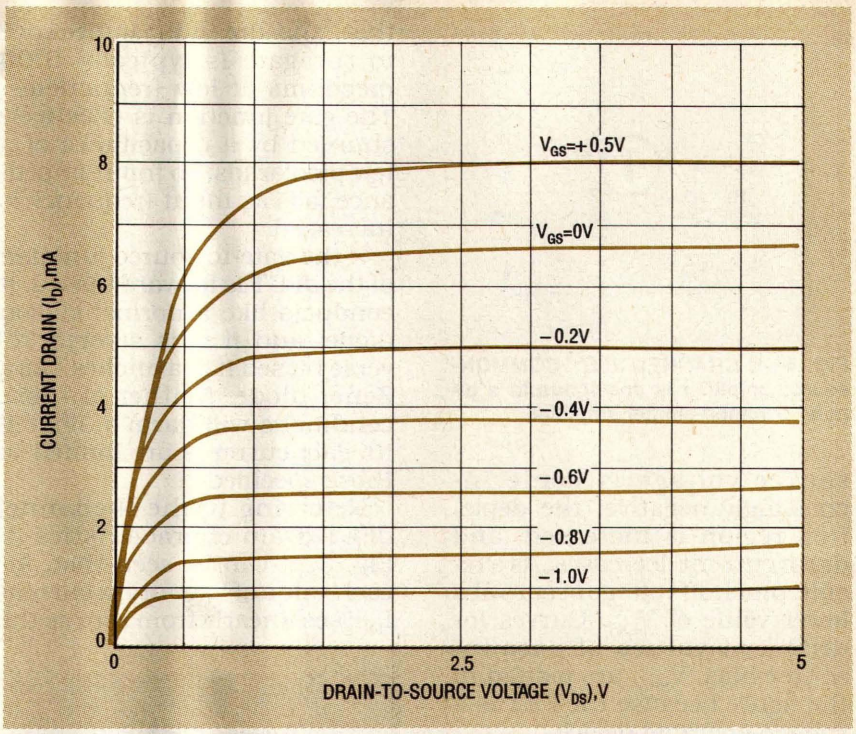


FIG. 8—DRAIN CURVES FOR N-CHANNEL DEPLETION-MODE MOSFET showing the effects of positive and negative bias

The schematic symbol for the N-type depeletion-mode MOSFET is shown in Fig. 7-b. The path or channel between the source and drain is shown as a solid bar. The symbol for the P-channel depletion-mode MOSFET is identical to the N-type, except that the arrow points outwards.

Figure 8 is a drain-to-source characteristic curve for an N-channel depletion-mode MOSFET. It can be seen that the current drain, I_D, is inversely proportional to the magnitude of the negative gate voltages, V_{GS}. Compare Fig. 8 with Fig. 3 for the N-channel JFET to see their similarities.

Planar *enhancement-mode* MOSFET's are made by the same methods as planar depletion-mode MOSFET's. However, the N-channel enhancement-mode MOSFET shown in Fig. 9 does not have the N-doped drain-to-source channel through the P-type substrate of the N-channel depletion-mode MOSFET. Therefore, there is no conduction between drain and source at zero gate bias.

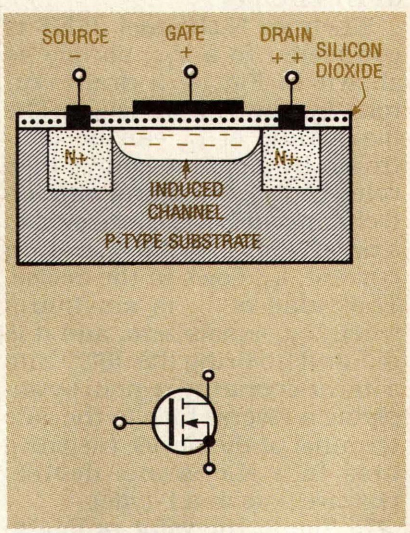


FIG. 9—N-CHANNEL ENHANCEMENT-mode MOSFET with positive grid bias (*a*), and schematic symbol (*b*).

To turn an enhancement-mode MOSFET on, positive gate bias is needed. As the gate voltage is increased, more electrons are induced into the channel. They cannot flow across the oxide layer to the gate, so they accumulate at the substrate surface below the gate oxide. When a sufficient number of

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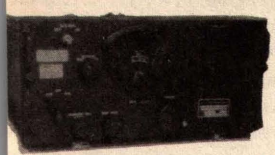

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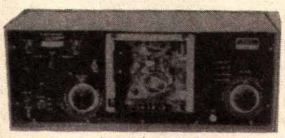

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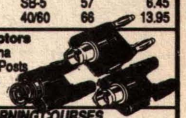

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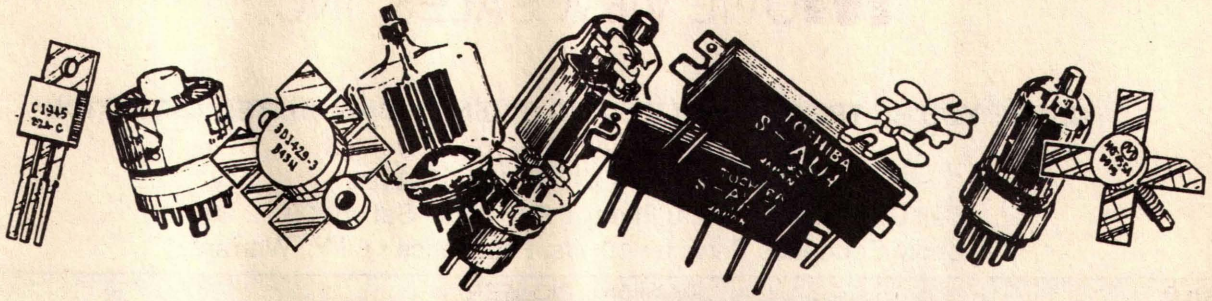

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MRF262	12.75	MRF966	4.35	2SC1307	CALL	2SC2640	17.00	M57745	83.25	6LR6 & 6LX6	CALL	7360	CALL	4CX250R PL	99.95
MRF264	13.45	MRF1946	15.00	2SC1419	4.70	2SC2782	37.75	M57747	39.25	6MJ6	CALL	7558	14.95	4CX300A	199.95
MRF327	62.00	RF120	CALL	2SC1729	13.25	2SC2783	59.85	M57762	69.95	12BY7A	11.75	7581/KT66	17.95	4CX350A,F	CALL
MRF421	22.95	SD SERIES	CALL	2SC1945	4.95	2SC2879	19.95	M57785M	54.95	12J86 GE	19.95	8072	169.95	4CX1500B EI	710.00
MRF422	34.95	SRF2072	13.75	2SC1946A	15.65	2SC2904	30.50	M57796MA	29.50	27LF6 NAT	21.95	8122	159.95	4CX5000A	995.00
MRF433	12.20	SRF3662	27.70	2SC1947	9.75	2SC2905	34.50	M67715	55.75	2OLF6	19.95	8417 GE	19.95	4D32	119.95

Mfgr: EI = Eimac, PL = Penta Labs Note: (#) = Industrial Boxed Eimac/Amperex Limited Warranty: 12 month / 3,000 hours on Penta & Eimac transmitting tubes

Price & availability subject to change without notice • Quantity Pricing Available

TECHNICAL BOOK	NET
ARRL RADIO AMATEURS HANDBOOK, 1992 Edition, (The "Bible") 5-1/4 lb.	$25.00
ARRL ANTENNA BOOK. HF/VHF/UHF-Wire Ant's/Beams. 16th Ed. 4 lb.	20.00
ARRL ANTENNA IMPEDANCE MATCHING 1.8 LB.	15.00
ARRL REFLECTIONS/TRANSMISSION LINES AND ANTENNAS 1.8 LB.	20.00
ARRL DATA BOOK. Formulas, schematics, tables, etc. 1.3 LB.	12.00
ARRL TRANSMISSION LINE TRANSFORMERS, 2nd ed. Baluns/etc. 1.4 LB.	20.00
ARRL NOW YOUR TALKING. NEW NO-CODE Novice/Tech License Study Guide 1.8 LB.	19.00
ARRL YOUR INTRODUCTION TO MORSE CODE. Novice & Tech 5 wpm Tapes	10.00
ARRL RADIO FREQUENCY INTERFERENCE, How to find it and fix it	15.00
ARRL LICENSE MANUAL, TECHNICIAN CLASS & Novice w/ code	6.00
ARRL LICENSE MANUAL, GENERAL CLASS	6.00
ARRL REPEATER DIRECTORY. Current issue	6.00
ARRL YOUR GATEWAY TO PACKET RADIO 1.2 LB.	12.00
ARRL UHF/MICROWAVE EXPERIMENTERS MANUAL 2.5 LB.	20.00
ARRL SATELLITE EXPERIMENTERS HANDBOOK	20.00
ARRL THE COMPLETE DX'er. Techniques/Tips/QSL	12.00
PASSPORT TO WORLD BAND RADIO. Short Wave Listening & freq. 1.8 LB.	14.95
MOTOROLA RF DEVICE MANUAL (incl. Appl. Notes & Cross Ref. 4.3 lbs)	14.95
ECG Semiconductors Master Replacement Guide/Specs. ECG-212Q 3 lbs	4.95

TECHNICAL BOOK		NET
RADIO/TECH MODIFICATIONS Freq Exp. HF/VHF Icom/Kenwood/Yaesu/Scanners		$19.95
U.S. REPEATER MAPBOOK Location/frequency geographically		9.95
SCANNER REPAIR & MODIFICATION MANUAL. Bearcat/Uniden. Vol. I		29.95
SERVICE MANUAL AR-3300 & AR-3500 Ranger 10M Xcvr.		20.00
SERVICE MANUAL for CYBERNET "Export" Radios		15.00
SERVICE MANUAL FOR UNIDEN "Export" Radios		15.00
SERVICE MANUAL RCI-2950 10M Xcvr.	*NEW!*	15.00
SERVICE MANUAL RCI-5500/6500/8500 VHF Marine Transceiver		17.50
UNDERSTANDING & REPAIRING CB RADIOS. Lou Franklin. 2 lb.	*Special*	34.95
ENGINEERS SECRETS OF RADIO. Tube Amps/Modulation tips/Schematics/TVI		16.95
CB PLL DATA BOOK, New International Edition, L. Franklin		19.95
CB TRICKS OF THE TRADE. Test/peaking/antennas/ & much more		15.95
CB TRICKS II. Schematics of popular linear amps & more		15.95
CB TUNE UP MANUAL, Master Edition, What to cuttweek mods., etc.		24.95
CB TUNE UP MANUAL, Master Ed./Vol. II. More info on popular xcvrs		29.95
CB TUNE UP MANUAL, Master Ed./Vol. III. Additional info on other equip.	Special	29.95
RADIO SECRETS. (Secret CB) Performance Improvements on Amateur & CB transmitters/amplifiers/mods/etc. Vol. 1-30 Reg. $20.00/vol.		14.95
SECRET CB Index. Listing by model number and article		2.50

Monday – Friday 7:30 a.m. – 5 p.m. PST / 10:30 a.m. – 8 p.m. EST

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Federal Express / Airborne / DHL / USPS are also available.

GROUND SERVICE: 3-7 working days (max.) depending on destination in contig. U.S.
$4.00 minimum. Add $.50 per pound above 2 pounds.

2-DAY AIR SERVICE: UPS BLUE, $6.00 minimum. Add $1.00 per pound above 2 pounds. Federal Express also available at same charge. No COD. Alaska / Hawaii / Puerto Rico. Canada: No COD. Please ask for charges.

NEXT DAY DELIVERY: UPS RED, $13.50 minimum. Ask for shipping charges above 1 lb.
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PAYMENT METHOD: PREPAID with check or money order. Personal checks must have preprinted address and are limited to $40.00. Checks returned for insufficient funds will be subject to a $20.00 charge. Any over-payment will be returned. Prepaid orders are not subject to minimum.
VISA/MASTERCARD accepted.
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OPEN ACCOUNT: Net 30 accounts to firms whose credit has been pre-approved.

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FOREIGN: Insurance/Registration is often available. Advise if desired.
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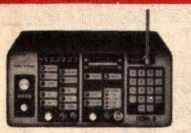
CIRCLE 268 ON FREE INFORMATION CARD

RAMSEY ELECTRONICS



COM-3 $299.95

2 WAY RADIO SERVICE MONITOR

COM-3, the world's most popular low-cost service monitor. For shops big or small, the COM-3 delivers advanced capabilities for a fantatic price—and our new lease program allows you to own a COM-3 for less than $3.00 a day. Features •Direct entry keyboard with programmable memory •Audio & transmitter frequency counter •LED bar graph frequency/error deviation display •0.1–10.000 µV output levels •High receive sensitivity, less than 5 µV •100 kHz to 999.9995 MHz •Continuous frequency coverage •Transmit protection, up to 100 watts •CTS tone encoder, 1 kHz and external modulation.

RSG-10 $249.95

SYNTHESIZED SIGNAL GENERATOR

Finally, a low-cost lab quality signal generator—a true alternative to the $7,000 generators. The RSG-10 is a hard working, but easy to use generator ideal for the lab as well as for production test. Lease it for less than $3.00 a day. Features •100 kHz to 999 MHz •100 Hz resolution to 500 MHz, 200 Hz above • – 130 to + 10 dBm output range •0.1 dB output resolution •AM and FM modulation •20 programmable memories •Output selection in volts, dB, dBm with instant conversion between units •RF output reverse power protected •LED display of all parameters—no analog guesswork!

FREQUENCY COUNTERS

CT-70 7 DIGIT 525 MHz

CT-90 9 DIGIT 600 MHz

CT-125 9 DIGIT 1.2 GHz

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for its lab quality products at breakthrough prices. All of our counters carry a full one-year warranty on parts and labor. We take great pride in being the largest manufacturer of low-cost counters in the entire U.S.A. Compare specifications. Our counters are full-featured, from audio to UHF, with FET high impedance input, proper wave shaping circuitry, and durable high quality epoxy glass plated-thru PC board construction. All units are 100% manufactured in the U.S.A. All counters feature 1.0 ppm accuracy.

NEW CT-250 2.5 GHZ

ACCESSORIES FOR COUNTERS

Telescopic ship antenna—BNC plug, WA-10	$11.95
High impedance probe, light loading, HP-1	$16.95
Low-pass probe, audio use, LP-1	$16.95
Direct probe, general purpose use, DC-1	$16.95
Tilt bail, elevates counter for easy viewing, TB-70	$ 9.95
Rechargeable internal battery pack, BP-4	$ 8.95
CT-90 oven timebase, 0.1 ppm accuracy, OV-1	59.95

ALL COUNTERS ARE FULLY WIRED & TESTED

MODEL	FREQ. RANGE	SENSITIVITY	DIGITS	RESOLUTION	PRICE
CT-50	20 Hz–600 MHz	<25 mV to 500 MHz	8	1 Hz, 10 Hz	$189.95
CT-70	20 Hz–550 MHz	<50 mV to 150 MHz	7	1 Hz, 10 Hz, 100 Hz	$139.95
CT-90	10 Hz–600 MHz	<10 mV to 150 MHz <150 mV to 600 MHz	9	0.1 Hz, 10 Hz, 100 Hz	$169.95
CT-125	10 Hz–1.25 GHz	<25mV to 50 MHz <15 mV to 500 MHz <100 mV to 1 GHz	9	0.1 Hz, 1 Hz, 10 Hz	$189.95
CT-250	10 Hz–2.5 GHz typically 3.0 GHz	<25 mV to 50 MHz <10 mV to 1 GHz <50 mV to 2.5 GHz	9	0.1 Hz, 1 Hz, 10 Hz	$249.95
PS10B Prescaler	10 MHz–1.5 GHz, divide by 1000	<50 mV	Convert your existing counter to 1.5 GHz		$89.95

SPEED RADAR $89.95 complete kit SG-7

New low-cost microwave Doppler radar kit "clocks" cars, planes, boats, horses, bikes or any large moving object. Operates at 2.6 GHz with up to 1/4 mile range. LED digital readout displays speed in miles per hour, kilometers per hour or feet per second! Earphone output allows for listening to actual doppler shift. Uses two 1-lb coffee cans for antenna (not included) and runs on 12 VDC. Easy to build—all microwave circuitry is PC stripline. ABS plastic case with speedy graphics for a professional look. A very useful and full-of-fun kit.

BROADBAND PREAMP

Boost those weak signals to your scanner, TV, shortwave radio or frequency counter. Flat 25 dB gain, 1 to 1000 MHz. 3 dB NF. BNC connectors. Runs on 12 VDC or 110 VAC.

PR-2, wired, includes AC adapter $59.95

2M POWER AMP

Easy to build power amp has 8 times power gain, 1W in, 8W out, 2W in, 16W out, 5W is for 40W out. Same amp as featured in many ham magazine articles. Complete with all parts, less case and T-R relay.

PA-1, 40W pwr amp kit $34.95
TR-1, RF sensed T-R relay kit $11.95

FM WIRELESS MIKE KITS

FM-3 SHOWN

Pick the unit that's right for you. All units transmit stable signal in 88–108 MHz FM band up to 300' except for hi power FM-4 that goes up to ½ mile.

FM-1, basic unit ..... $ 5.95
FM-2, as above but with added mike preamp ..... $ 7.95
FM-4, long range, high power with very sensitive audio section, picks up voices 10' away $14.95

MC-1, miniature sensitive mike cartridge for FM-1, 2, 4 ..... $ 2.95

MICROWAVE INTRUSION ALARM

real microwave Doppler sensor that will detect a human as far as 10 feet away. Operates on 1.3 GHz, and is not affected by heat, light, or vibrations. Drives up to 100 mA output, normally open or closed, runs on 12 VDC. Complete kit MD-3 . $19.95

MUSIC MACHINE

Neat kit that will produce 25 different classical and popular tunes, plus 3 doorchime sounds. Lots of fun for doorbells, shop, or store entrances, car horn, music boxes, etc. Runs on 9V battery or wall transformer. Excellent speaker volume and adjustable tempo and pitch. Add our case set for a handsome finished look.

Complete kit, MM-5 ..... $24.95
Case + knob set, CMM-5 $12.95

PACKET RADIO

Two new versions are available for the Commodore 64 (P-64A) or the IBM-PC (P-IBM). Easy assembly "NO TUNING". Includes FREE disk software, PC Board and Full Documentation.

KIT P-64A $59.95
P-IBM $59.95
CASE CPK $12.95

LO NOISE PREAMPS

Make that reciever come ALIVE! Small size for easy installation with Hi-Q tuned input for peak performance. Excellent gain and noise figure—guaranteed to improve reception! Specify band: 2M—PR-10, 220 MHz—PR-20, 440 MHz—PR-40.

Each kit $17.95

PHONE DECODER

complete tone decoder a single PC board. Features: 400–5000 Hz adjustable range via 20-turn pot, voltage regulation, 567 IC. Useful for touch-tone test detection, FSK, etc. can also be used as a station tone encoder. Runs on 9 to 12 volts.

Complete kit, TD-1 $6.95

VOICE ACTIVATED SWITCH

Voice activated switch kit provides switched output with current capability up to 100 mA. Can drive relays, lights, LED, or even a tape recorder motor. Runs on 9 VDC.

VS-1 kit $6.95

TELEPHONE TRANSMITTER

Mini-sized with professional performance. Self-powered from phone line, transmits in FM broadcast band up to ¼ mile. Installs easily anywhere on phone line or inside phone!

PB-1 kit $14.95

NEW

SPEAKER PHONE

Talk on the phone hands-free, great to put in shop or shack, press the button to answer—no actual phone needed. Works same as commercial units. Talk from anywhere in room, phone line powered—no battery needed. Super for family and conference calls or buy two for hands-free intercom! Add our case set for a pro look.

SP-1 ..... $29.95 Case-CSP $12.95

CKLE STIK

shocking kit! Blinking LED attracts victims to pick up innocent-looking can—you watch the fun! Ideal for office desks, parties, nosey know-alls!

K-4 kit $9.95

LIGHT BEAM COMMUNICATORS

Transmits audio over infrared beam up to 30'—use simple lenses to go up to ¼ mile! Hum free, uses 30 kHz carrier. Great for wireless earphones or undetectable "bug." Transmitter + receiver set, LB56 .. $19.95

FM RADIO

Full-fledged superhet, microvolt sensitivity, IC detector and 10.7 MHz IF. Tunes Std. FM broadcast band as well as large portions on each end. Ideal for "bug" receiver, hobby experiments or even as FM radio!

FR-1 kit $19.95

SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2W rms output. Runs on 6 to 15 volts, uses 8–45 ohm speaker.

BN-9 kit $6.95

BROADBAND PREAMP

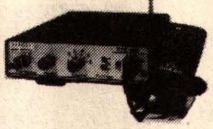
Very popular sensitive all-purpose preamp, ideal for scanner, TVs, VHF/UHF rigs, counters. Lo noise, 20 dB gain, 100 kHz–1 GHz, 9V–12 VDC operation.

SA-7 kit $14.95

•2 METERS •223 MHz •440 MHz

FANTASTIC FM TRANSCEIVERS

SYNTHESIZED—NO CRYSTALS



$149.95

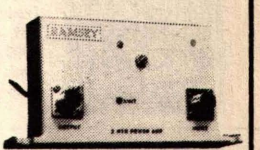
Ramsey breaks the price barrier on FM rigs! The FX is ideal for shack, portable or mobile. The wide frequency coverage and programmable repeater splits makes the FX the perfect rig for Amateur, CAP or MARS applications. Packeteers really appreciate the dedicated packet port, "TRUE-FM" signal and almost instant T/R switching. High speed packet? ....No problem. Twelve diode programmed channels, 5W RF output, sensitive dual conversion receiver and proven EASY assembly. Why pay more for a used foreign rig when you can have one AMERICAN MADE (by you) for less. Comes complete less case and speaker mike. Order our matching case and knob set for that pro look.

FX-146 kit (2 Meters)	$149.95
FX-223 kit (1¼ Meters)	$149.95
FX-440 kit (3/4 Meters)	$169.95
CFX matching case set	$ 24.95

2 MTR & 220 BOOSTER AMP

Here's a great booster for any 2 meter or 220 MHz hand-held unit. These power boosters deliver over 30 watts of output, allowing you to hit the repeater's full quieting while the low noise preamp remarkably improves reception. Ramsey Electronics has sold thousands of 2 meter amp kits, but now we offer completely wired and tested 2 meter, as well as 220 MHz, units. Both have all the features of the high-priced boosters at a fraction of the cost.

PA-10 2 MTR POWER BOOSTER (10 X power gain)
Fully wired & tested $89.95
PA-20 220 MHz POWER BOOSTER (8 X power gain)
Fully wired & tested $89.95



QRP TRANSMITTERS HAM RECEIVERS

20, 30, 40, 80M CW TRANSMITTERS

Join the fun on QRP! Thousands of these mini-rigs have been sold and tons of DX contacts have been made. Imagine working Eastern Europe with a $30 transmitter—that's ham radio at its best! These CW rigs are ideal mates to the receivers at right. They have two-position variable crystal control (one position QRP XTAL included), one watt output and built-in antenna switch. Runs on 12VDC. Add our matching case and knob set for a handsome finished look.

Your choice of bands $29.95
(Specify band: QRP-20, 30, 40 or 80)
Matching case & knob set, CQRP $12.95

20, 30, 40, 80M All Mode RECEIVERS

Build your own mini ham station. Sensitive all-mode AM, CW, SSB receivers use direct conversion design with NE602 IC as featured in *QST* and ARRL handbooks. Very sensitive varactor tuned over entire band. Plenty of speaker volume. Runs on 9V battery. Very EASY to build, lots of fun and educational—ideal for beginner or old pro. New 30-page manual. Add the case set for well-fitted professional look.

Your choice of bands $29.95
(Specify band: HR-20, HR-30, HR-40, HR-80)
Matching case & knob set, CHR $12.95

E-Z KEY CMOS KEYER

Send perfect CW within an hour of receiving this kit! Easy-to-build kit has sidetone oscillator, speed control and keys most any transmitter. Runs for months on a 9V battery. 28-page manual gives ideas on making your own key for extra savings. Add our matching case set for complete station look.

CW-7 kit $24.95
Matching case knob set, CCW $12.95

2, 6, 10 MTR, 220 FM RECEIVERS

Keep an ear on the local repeater gang, monitor the cops, check out the weather or just plain listen around. These sensitive superhet receivers are just the ticket. They tune any 5 MHz portion of the band and have smooth varactor tuning, dual conversion with ceramic IF filters, AFC, adjustable squelch and plenty of speaker volume. Runs on 9V battery and performance that rivals the big rigs! For a complete finished pro look, add our matching case and knob set with screened graphics.

FM communications receiver kit $29.95
Specify band: FR 146 (2m), FR6 (6m), FR10 (10m), FR-220 (220 MHz)
Matching case & knob set, CFR $12.95

ACTIVE ANTENNA

Cramped for space? Get longwire performance with this desktop antenna. Properly designed unit has dual HF and VHF circuitry and built-in whip antenna, as well as external jack. RF gain control and 9V operation makes unit ideal for SWLs, traveling hams or scanner buffs who need hotter reception. The matching case and knob set gives the unit a hundred dollar look!

AA-7 Kit $24.95
Matching case & knob set, CAA $12.95

SPEECH SCRAMBLER

Communicate in total privacy over phone or radio. Kit features full duplex operation using frequency inversion. Both mike and speaker or line in/out connections. Easy hookup to any radio, and telephone use requires no direct connection! Easy to build 2 IC circuit. Can also be used to descramble many 2-way radio signals. Finish your kit off with the handsome case & knob set.

SS-7 kit $29.95
Matching case & knob set, CSS $12.95

FM STEREO TRANSMITTER

Run your own stereo FM station! Transmit a stable signal in the standard FM broadcast band throughout the house, dorm or neighborhood. Connects easily to line outputs on CD player, tape decks, etc. Runs on 9V battery, has internal whip antenna and external antenna jack. Add our case set for a "station" look!

FM-10 kit $29.95
Matching case set, CFM $12.95

SHORTWAVE RECEIVER

Fantastic receiver that captures the world with just a 12" antenna! Can receive any 2 MHz portion from 4–11 MHz. True superhet has smooth varactor tuning, AGC, RF gain control, plenty of speaker volume and runs on a 9V battery. Fascinating Scout, school or club project provides hours of fun for even the most serious DXer. For the car, consider our shortwave converter. Two switchable bands (in 3–22 MHz range), each 1 MHz wide—tunable on your car radio dial. Add some interest to your drive home!

Shortwave receiver kit, SRI $29.95
Shortwave converter kit, SCI $27.95
Matching case set for SRI, CSR $12.95
Matching case set for SCI,CSC $12.95

AIRCRAFT RCVR

Hear exciting aircraft communications—pick up planes up to 100 miles away! Receives 110–136 MHz AM air band, smooth varactor tuning superhet with AGC, ceramic filter, adjustable squelch, excellent sensitivity and lots of speaker volume. Runs on 9V battery. Great for air shows or just hanging around the airport! New 30-page manual details pilot talk, too. Add case set for "pro" look.

AR-1 kit $24.95
Matching case set, CAR $12.95

TERMS: Satisfaction guaranteed. Examine for 10 days. If not pleased return in original form for refund. •Add $3.75 for shipping, handling and insurance. •For foreign orders add 20% for surface mail. •COD (U.S. only) add $5.00. • Orders under $20, add $3.00. •NY residents add 7% sales tax. •90-day parts warranty on kit parts. •1-year parts & labor warranty on wired units.

PHONE ORDERS CALL 716-924-4560

FAX 716-924-4555

RAMSEY ELECTRONICS, INC. 793 Canning Parkway, Victor, NY 14564

CATALOG DISCOUNT SALE!!!

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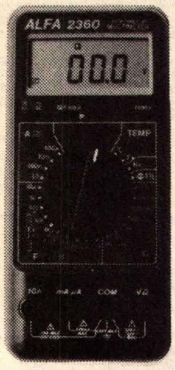
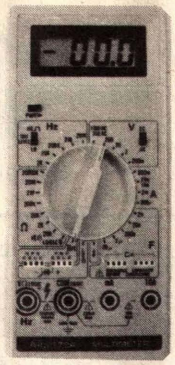
QUALITY TEST EQUIPMENT
AFFORDABLE PRICE



DMM 2360 $129.95

DMM + LCR Meter
Most Versatile DMM

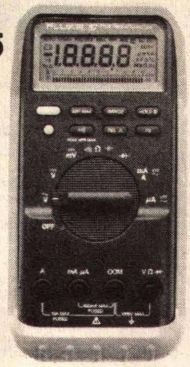
Inductance: 1µH-40H
Capacitance: 1pF-40µF
Frequency: 1Hz - 4MHz
Temperature: -40 - 302°F
Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off



DMM 175A $67.95

DMM with 20 MHz Frequency Counter
Most popular DMM

Freq. Counter 1Hz-20MHz
DCV .1mV-1000V
ACV .1mV-750V
ACA/DCA .1mA-10A
R .1Ω-2000MΩ
Cap 1pF-20µF
TTL Logic test 20 MHz
Transistor HFE test
Diode test
LED test
3 ½ digit display
10 MΩ impedance



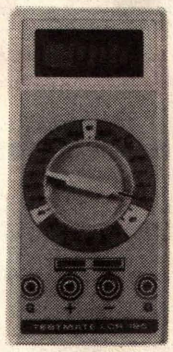
Fluke Multimeter

Fluke 70 II		$62
Fluke 73 II		$87
Fluke 75 II		$125
Fluke 77 II		$145
Fluke 79 II		$165
Fluke 83		$215
Fluke 85		$255
Fluke 87	True RMS	$285
Fluke 86	Automotive	$359
Fluke 88		$419

LCR Meter 814 $199.95

The Best Handheld LCR

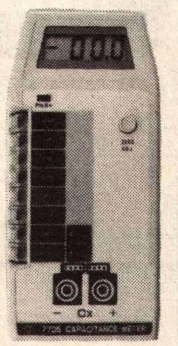
Inductance:0.1µH-200H
Capacitance:0.1pF-20,000µF
Resistance:1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Very good for high frequency RF and surface mount components.



LCR Meter 195 $119.95

Very popular LCR

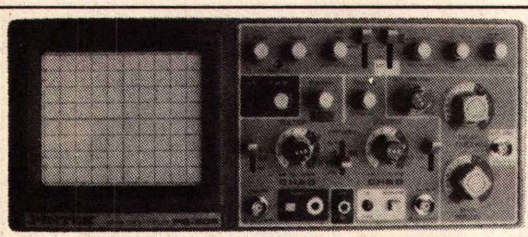
Inductance:1µH-200H
Capacitance:0.1pF-200 µF
Resistance:0.01Ω-20MΩ
Basic accuracy:R:1%, C:2%, L:3%
Test frequency 1 kHz



Capacitance Meter 7705 $57.95

0.1 pF-20,000µF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate parasitics from test fixture

Also Available:
Heavy duty DMM
AC/DC clamp meter
Thermometer, Lux meter
pH meter, Logic probe
High voltage probe
RC oscillator
Electronic scale
Frequency counter



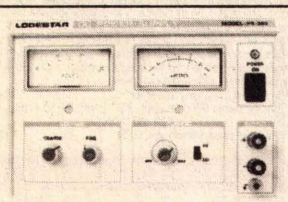
20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes x1, x10. Best price with delay sweep.

PS-200 20MHz	DUAL TRACE	$339.95
PS-405 40MHz	DELAY	$569.95
PS-605 60MHz	DELAY	$769.95

20 MHz Digital Storage Oscilloscope DS-203 $769.9

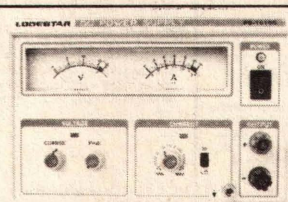
Switchable between digital and analog
2 K word per channel storage
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerels/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all, Save CH2, Pre-Trig
Plotter Control



Power Supply PS-303 $169.95

0-30 VDC , 0-3A output

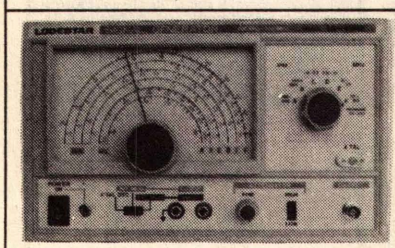
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected



Power Supply PS-1610 $299.95

0-16 VDC , 0-10A output

Constant voltage & constant current mod
0.2%+2mV line regulation
0.04% +2mV load regulation
1mVrms noise and ripple
Short circuit and overload protected



RF SIGNAL GENERATOR SG-4160B $124.95

100 kHz-150MHz sinewave in 6 ranges
Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz modulation

AUDIO GENERATOR AG-2601A $124.95

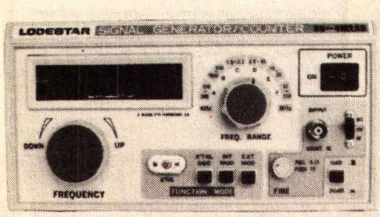
10Hz - 1MHz in 5 ranges
Output: 8Vrms sine, 10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion: 0.05% 500Hz - 50kHz
0.5% 50Hz - 500kHz
Output impedance: 600 ohm

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz - 2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN./COUNTE FG-2102AD $234.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output



RF SIGNAL GEN./COUNTER SG-4162AD $234.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz -150MHz
Sensitivity <50mV
For internal and external sources

AUDIO GEN./COUNTER AG-2603AD $239.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz
Sensitivity <50mV
For internal and external sources

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0.5MHz to 5 MHz
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ATH™ - BAR GRAPH FREQUENCY COUNTERS

Check out the ALL NEW ATH-15 . . . it's FAST !

The ATH-15 can ACCURATELY READ an input signal, DISPLAY the frequency and AUTOMATICALLY switch to HOLD status, in less than 8% of a second !!

- **ATH™ - AUTO TRIGGER & HOLD**
- ONE-SHOT *ATH™* OPTION
- AUTOMATIC CLEAN DROPOUT
- *800%* FASTER RESPONSE TIME
- *ULTRA BRIGHT* LED DIGITS
- MAXIMIZED SENSITIVITY < 1mV typ
- 3 to 5 HOUR NI-CADs STANDARD
- *BATTERY CHARGE* INDICATOR
- 4 GHZ - 2 INCH LED BAR GRAPH
- 2 RANGES - 6 *FAST* GATE TIMES
- 1 PPM TCXO STANDARD
- HIGH STAB 0.2PPM TCXO OPTION
- MANUAL HOLD FUNCTION
- BLANK DISPLAY FUNCTION
- 9-12V *AUTO-POLARITY* PWR JACK
- ***StarCab™*** ALUMINUM CABINET
- 1 YEAR LIMITED WARRANTY

ATH™ refers to our exclusive new *AUTOMATIC TRIGGER & HOLD* circuit with *AUTOMATIC CLEAN DROPOUT*. With **ATH™** you can say good-bye to almost all of that annoying random counting and the false readings we have become accustomed to when using portable counters. The model **ATH-15** is an *ULTRA HIGH SENSITIVITY*, 1 MHz to 1500 MHz frequency counter with an INTEGRATED BAR GRAPH circuit which ***instantly*** displays the signal strength of an input signal from < 1 MHz to over 4 GHz. When the **ATH™** feature is used, the counter displays the last readable signal received. It automatically triggers on a readable signal and automatically switches to the "hold" status when the signal dissapears. Because of *AUTO TRIGGERING*, the first reading is correct. If the signal stops in the middle of a sample or gate time, the last complete accurate reading will be displayed and the unit switched back to "HOLD" status, hence the *AUTOMATIC CLEAN DROPOUT* prevents the display of erroneous data, all this is done automatically, with hands free operation - and it works great !!!

We are further responding to user requests by offering a *ONE-SHOT* **ATH™** option. This consists of a *ONE-SHOT* select switch, a push button *RESET* switch and two LED indicators all located on the top of the counter (not shown). When this function is used, the first readable signal that triggers the counter will be held on the display until manually reset. One push of the reset button will reset the display to zeros and enable the one-shot circuit again. The display can be blanked or turned off pending the auto triggering from an input signal, which also saves power under battery operation.

RESPONSE TIME, defined as the time from the beginning of the input signal to a stable, accurate, readable display, has been dramatically speeded up. The RESPONSE TIME is actually 800% faster than previous models and if you consider not having to manually throw the hold switch, at just the right time, the **ATH-15** is functionally the fastest counter you can buy !!

MADE IN USA

SAY *GOOD-BYE* TO RANDOM COUNTING & FALSE READINGS

ATH-15

SIZE: 4"H x 3.5"W x 1"D

#ATH-15	FREQUENCY COUNTER WITH NI-CADs & 110VAC ADP	$235.
FACTORY INSTALLED OPTIONS:		
#O/S-ATH-15	ONE-SHOT ATH™	40.
#HSTB-15	HIGH STAB TCXO 0.2ppm	100.
ACCESSORIES:		
#CC-90	BLACK VINYL ZIPPER CASE	12.
#TA-90	TELESCOPING BNC ANTENNA	12.
#P-110	PROBE, 200 MHZ, 1X-10X	39.
#M207IC	CABLE FOR MFJ-207/208	10.

CHECK IT OUT. . . BEFORE YOU BUY A COUNTER

Does Bar Graph give *INSTANT* readings or 3 gate times delayed?
Does Bar Graph work on every range? Over 2 GHz? With HOLD on?
Does HOLD switch *CHANGE* the GATE selection when turned off?
Does unit *SELF-OSCILLATE* - random count with no input signal?
How many switches needed to select range? Gate times per range?
How long does unit operate with batteries? One hour?
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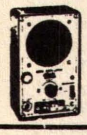
A solid-state code practice oscillator and monitor that uses the latest IC circuitry. It contains a 3" built-in speaker, headphone terminals, a volume control and a tone control. It is a attractively packaged with a two color panel. With the addition of a few parts, the unit can easily be converted into CW monitor. It can there fore be used as an operating aid after the code has been learned.



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Wired $24.95

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NE564	1.75
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LM741	.30
UA7805	.39
UA7812	.39
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2N2222A	.35
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#16	3.30	#26	3.75
#18	3.35	#28	3.85
#20	3.55	#30	4.00
#22	3.65	#32	4.40
#34	4.80		
#36	4.90		
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T-37-12	.45	FT50-43	.75
T-50-2	.55	FT50-61	.75
T-50-3	.55	FT50-77	.75
T50-6	.55	FT82-43	1.00
T68-0	.75	FT82-67	1.00
T68-2	.75	FT82-68	1.00
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JUST 3 EASY STEPS:

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Convenient 8 1/2 x 11 size With Complete Instructions

5 SHEETS $6.25
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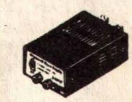

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10 AMP $79.50
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LO/RF - 1-500MHz
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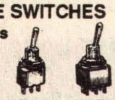

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DPDT .....ON-ON.....**$1.50**

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DIGITAL LCR METER measures inductance, capacitance and resistance. At Last! An LCR meter that everyone can afford. Now you can measure coils, transformers, chokes from 1µH to 200H. Capacitors from .1 pfd to 200 mfd and resistors from .1 ohms to 20 meg ohms. All in one handheld instrument.

MODEL LCR-1801 .....$119.95

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- 13" TV with VCR
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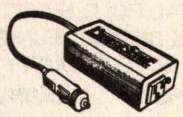

Model: POW 200
Input: 10 to 15 volts DC
Output: 115 volts AC true RMS
Power: 400 Watts peak
200 Watts for 2 minutes
140 Watts continously
5" x 2.6" x 1.7"
Weight: 15 ounces
Warranty: 3 year

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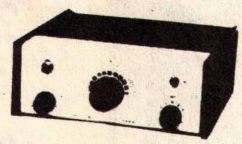
QRP CW TRANSCEIVER KIT



- Covers 14.0 MHz to 14.1 MHz on 20 M or covers 7.0 MHz to 7.150 MHz on 40M
- Available on 20M or 40M band
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- VFO tuning with vernier dial
- RIT w/center detent control
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- 2-3 watts of RF output
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- 12VDC operation
- Custom pre-painted, punched & silkscreened cabinet
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- Weight 24 oz.

QRP-20 .....20M VERSION $149.95

QRP-40 .....40M VERSION $149.95

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This handy tester is both a signal generator and receiver. As a generator use it to check out an amplifier, stage by stage. Also tests AM radio IF and RF stages. As a receiver you can pin point where a defective part exists. Will transmit and receive simultaneously.

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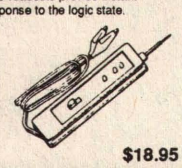

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200µA movement. Scale reads signal 0-60db. Has two ear flanges with holes for mounting.

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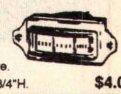

200µA movement. Scale reads both signal (0-30db) and SWR. Same mounting as above.

Measures 1 3/8"W x 1 1/4"D x 3/4"H. **$4.00**

MULTIVOLTAGE AC ADAPTER

Rated 500MA
Input 117VAC
Output 3V, 4.5V, 6V, 7.5V, 9V, 12V DC
Polarity switch
Universal plug

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1N5400	.20
1N5401	.20
1N5402	.20
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1N5406	.25
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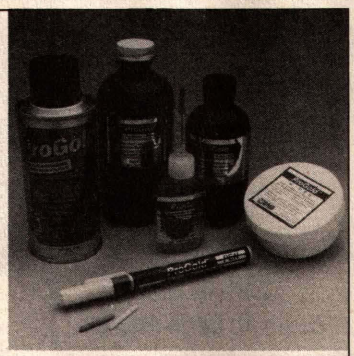
Gold Conditioner & Protector



- Protects Gold Surfaces & Base Metals!
- Improves Conductivity!
- Forms Protective & Anti-tarnish Coating!
- Reduces Wear & Abrasion!
- Reduces Arcing & RFI!
- Reduces Intermittent Connection Failures!

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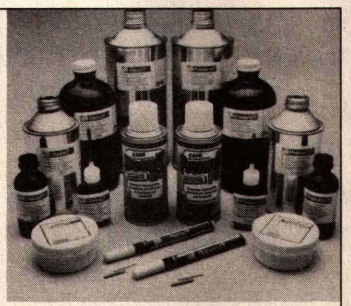
DeoxIT™ & PreservIT™
Improves Conductivity and Protects Electrical Connections



- Improves Conductivity
- Reduces Intermittent Connection Failures
- Reduces Arcing & RFI
- Reduces Wear & Abrasion
- Extended Temperature Range, -34°C to 200°C

DeoxIT, a one step treatment, is a fast-acting deoxidizing solution that cleans, preserves, lubricates and improves conductivity on all metal surfaces. Temperature range -34°C to 200°C. Non-flammable, non-toxic, non-corrosive, non-gumming, ozone-safe.

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These new advanced formulas contain improved deoxidizers, preservatives, conductivity enhancers, anti-tarnishing compounds, arcing & RFI inhibitors and provide extended temperature range. **DeoxIT's** new formulation also prevents dissolved oxides/contaminants from re-attaching to metal surfaces, providing longer lasting protection.

OpticALL™

Effectively cleans, polishes and eliminates static electricity on optical viewing surfaces. OpticALL is also recommended as a general purpose antistatic cleaner on plastic, glass and metal surfaces.

StaticALL™
Neutralizes static build-up caused by friction & low humidity conditions.

DustALL™

Quickly & safely removes dust, lint & particles from sensitive electronic equipment, computers, lab equip., optical grade surfaces & other mechanisms & equipment.

FreezALL™
Quickly and safely cools circuits to -54°C. Locates intermittent components due to heat failure and hairline cracks on PCBs.

MechanicALL™

High Penetrating Anti-Corrosive Anti-Tarnishing Cleaner & Lubricant. Lubricates & Protects, Displaces Moisture, Stops Squeaks, Migrates & Coats Entire Surface.

ElectricALL™
Rejuvenating Solution For All Electrical Applications. Cleans, Preserves, Improves & Protects Connections, Removes Corrosion & Oxidation, Reduces Wear, Abrasion, Arcing & RFI.

DegreasALL™

For degreasing, cleaning & defluxing equipment and parts. Removes oil, grease, dirt and contaminants including rosin flux from PCBs, components and metal parts. Biodegradable.

CAEON™ 27
For sensitive equip-ment applications. For removal of oil, grease & dirt from surfaces. (Freon® TF).

CAEON™ 28
Degreaser and clean-ing liquid removes organic contaminants including rosin flux from PCBs, components and metal parts. (Freon® TMC).

X-10S Instrument Oil

Contains silicone. Finest quality instrument oil for use on rubber, plastics and metals. Non-gumming, rust inhibiting, long lasting lubrication.

X-10 Instrument Oil
Lubricates precision instruments, fine parts & mechanisms. Use on all metals (gauges, gears, clocks, instruments, etc.). Non-gumming, rust inhibiting, long lasting lubrication.

*"We were having trouble with edge connectors in our manufacturing environment until we tried **ProGold Wipes**...great product."* J. P., General Electric

*"Static and dirt buildup on our CRT screens have always been an annoying problem. We have tested many products and find **OpticALL** to last considerably longer and work just as well on our plastic and metal enclosures."*

A. R., University of Maryland, College Park, Dept. of Physics & Astronomy

"For many years we have been using CAIG's liquid and spray products in the lab for service and repair of connectors, switches and potentiometers. I also use their paste products on my boat to prevent corrosion from salt water and air ... fine products for a variety of applications".

T. S., University of California, Lawrence Livermore National Laboratory

*"Corrosion problems on very sensitive connectors have been an annoying problem for us. We have tried many products without success until we tried CAIG's **DeoxIT**. DeoxIT is the only product that has worked perfectly. We highly recommend it".* R. V., Xerox Corporation

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Capitol Records	IBM	Tektronics
Diebold, Inc.	John Fluke Mfg.	Texas Instruments
Dolby Laboratories	McIntosh Labs	Wayne-Dresser
General Electric	Motorola	Xerox Corp.
Grumman Aerospace	Nakamichi	. . . and many more

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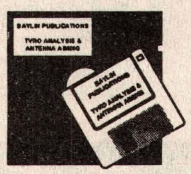
- Pansat BR 1100 Receiver
- Polar tracking mount
- Polarity switching feed
- Low Temperature LNB
- 100ft All in one ribbon cable

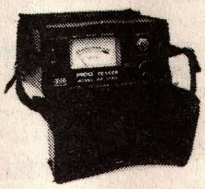
*Complete System **Only $479**



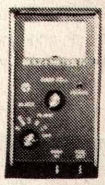
Satellite Analysis and Antenna Aiming Software

An extremely valuable tool for designing and installing TVRO's, tailored for ease of use by professionals and dealers as well as by technically orientated TVRO owners. Demonstrates how changing parameters such as dish size or LNB noise temperature affect picture quality. The program performs both TVRO system analysis and antenna aiming. The analysis subcomponent, is especially useful for predicting performance when viewing signals from a particularly weak satellite. The aiming subcomponent calculates azimuth and elevation angles and range to all satellites within "view" of a TVRO. The names and latitudes of all world-wide C and Ku-band broadcast satellites, presently in service or to be launched by 1995, are listed. The user simply enters TVRO site latitude and longitude.

5.25" disk	S&H $.4.75	$49.95
3.5" disk	S&H $.4.75	$49.95



Pico dish Tuning Meter



Bulz-I-Tuning Meter Now with audio alert

TUNE YOUR DISH TO IT'S MAXIMUM!

Dish tuning meters are a must for the serious dealer or satellite system owner. Saves time, frustration and money. Use when installing a new system, moving your dish, re-alignment of a dish that has been moved by wind, frost heaves etc., gets you right on the satellite belt for the best possible pictures!

Pico meter (meter tuning)	S&H $6	$89.95
Bulz-I-IV meter (meter & audio alert)	S&H $6	$149.95

DELUXE KU SYSTEM

Package INCLUDES all of this:

- Quality aluminum 3ft dish
- Pansat BR 3000 programmable receiver with IR remote control
- Pansat AP 3000 Antenna positioner with 77 satellite programmability
- Polar tracking mount and motorized arm
- Polarity switching feed
- Low Temperature LNB
- 100ft All in one ribbon cable

*All you need to supply is ground pole to mount dish on. (23/8" O.D.)

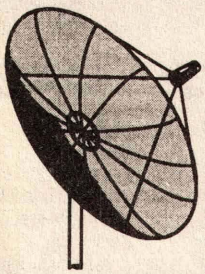
*Complete System **Only $698**

LNBs

New Lower Temp's

Hemt Technology Commercial Grade

45°	LNB C-band	4GHz	S&H $6	$ 69
35°	LNB	"	"	99
25°	LNB	"	"	139
1.2db	LNB Ku	12GHz	S&H $6	$ 99
1.0db	LNB	"	"	126
0.9db	LNB	"	"	139
0.7db	LNB	"	"	199
0.6db	LNB	"	"	229



MESH DISHES by ORBITRON

Quality Demonstrated by Performance

Orbitron antennas ("size for size") are known the world over for their superior reception and picture quality.

7ft	dish & polar tracking mount		$239
8.5ft	"	"	299
10ft	"	"	349
10ft H.D.	"	"	439
12ft	"	"	639

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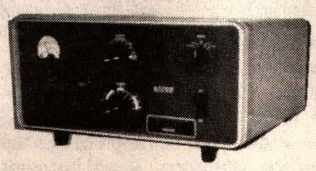
R.F. WATTMETER ME-82/U (MFG M.C. JONES MODEL MM-625)

Contains built in power load—oil filled.
Frequency Range: 50 to 600 MHZ.
Inpendance: 52 OHMS.
Power Level: 120 Watts.
Size: 6"W × 7"H × 13" Deep.
Weight: 10 lb. **Price: $150.00**

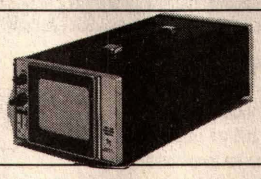


COLLINS 30L-1 LINEAR AMPLIFIER (S-LINE)

Frequency: 80, 40, 20, 15, 10 meters
3.4 to 5.0 MHZ, 6.5 to 9.5 MHZ
9.5 to 16 MHZ, 16 to 22 MHZ, 22-30 MHZ
Mode: SSD or CW
Power Out: 1000 W PEP, 1000W CW
Drive: 70-100 watts full output
Harmonic Distortion: −40 dBc 2nd
−30 dBc 3rd
Output Independance: 5052 VSWR <2:1
Power Requirements: 1200 watts CW
300 watts SSB no modulation
550 watts SSB speech modulation
Voltage 115V or 230V 50-60HZ
Wt: 38 lbs. **Size:** 14¾" × 7¾"H × 14"D
Price: $895.00

ANRITSU ML422B

Anritsu ML422B Programmable Selective Level Meter. Has synthesized frequency tuning (rotary dial on keypad entry). Automatic tone search for unknown signals, swept frequency, keypad data entry for amplitude and frequency limits, IEEE488 computer control capability. **Frequency range:** 50HZ to 30MHZ (8 digit LED readout). **Stability:** ≤ ± 5 × 10 − 7/0 to 45°C, ≤ ± 1 × 10 − 6/year. **Bandwidths:** Wideband, 48khz, 3.1khz and 20hz (−3dB). **Amplitude Range:** −120dBM to +30dBM depending on bandwidth setting (5 digit readout and meter). **Amplitude Accuracy:** ±0.15dB to ±1.5dB depending on level range and frequency setting. **Input Impedence:** 75 ohms terminated unbalanced or 10Kohm unterminated balanced. 75, 124, 135, or 600 ohms terminated balanced. 1.5Kohm and 20Kohm unterminated balanced. **Distortion:** Input ≤ ±10dBM, single tone, 2nd and 3rd order ≤ −70dBc from 1Khz to 12mhz. I.F. **Rejection:** ≤ −70dBM @ 56.6mHz, ≤ −80dB elsewhere. **Image Rejection:** ≤ −80dB. **Phase Jitter:** ≤0.5° p-p, 0.1° resolution. **Power:** 115V, 3.15A, 60hz AC. **Size:** 16 13/16"W × 7⅜"H × 19¾"D. **Wt:** 45 lb. **Price: $$6,500.00**



TEKTRONIX 528 SOLID STATE N.T.S.C. WAVEFORM MONITOR

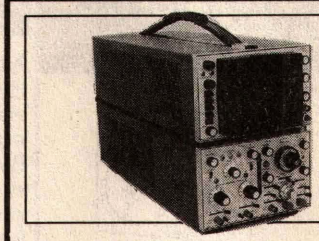
8 × 10 display, two composite video inputs
75 ohms, selectable 1 volt or 4 volt full scale, (140 IRE units)
YRGB and RGB inpuy. Video output response 25Hz to 5 MHz ≤3%.
FOUR RESPONSE POSITIONS: 1] Flat, 2] IRE, 3] Chroma, 4] Differential gain.
FOUR SWEEP MODES: 1] 2-V Sweep 1, 2] 2-V mag sweeep, 3] 2-H sweep, 4] 1 US sweep.
SIZE. 5'4"H × 8½"W × 18½"D
WEIGHT: 15 LBS
POWER: 115V 60 HZ 48 watts **Price: $495.00**

TEKTRONIX SOLID STATE PORTABLE 491 SPECTRUM ANALYZER

Frequency 10MHZ—2 GHZ with internal mixers. 1.5GH to 40GHZ with plug-in mixers for use to 12.4GHZ. Dispersion 1KHZ/div. to 10MHZ/div. **Coupled Resolution:** 1KHZ to 100KHZ. **Display Flatness:** over 100MHZ dispersion to 12.5GHZ ≤3dB above 12.5GHZ, ≤6dB. **Incidental FM:** ≤300HZ. **Frequency Stability:** (after warm up) ±10KHZ with line variation. ±5.0KHZ/°c with ±100KHZ, KHZ dispersion. ±20.0KHZ/°c with ±200KHZ, MHZ dispersion. Internal 1MHZ phase lock. Input Impedance 5052. **Max Input Power:** −30dBm (linear range), +15dBm (mixer limit). **I.F. Attenuator:** 51dB in 1d steps. **I.F. Gain:** >50dB. **Display:** Log, ≤40dB, Linear, ≤26dB, Square Law, ≤13dB. **Sweeptime:** 10 micro seconds to .5 Sec./div. CRT is 8 × 10 divisions (.8cm/div.). **Power Requirements:** 90K 136 VAC or 180 to 272VAC, 48 to 440HZ, 55 watts. **Size:** 7 3/16"H × 12 7/16"W × 19 11/16"D. **Weight:** 30 lbs. **Price: $1400.00**

COLLINS KWM—2A TRANSCEIVER

Frequency Range: 3.4 to 30 MHZ except 5.0 to 6.5MHZ. **Unit Cover:** 80, 40, 20, 15 and 10 meter. Amature bands. **Modes:** SSB, CW or RRTY. **Sensitivity:** 0.5 uv for 10 db S + N/N. **Selectivity:** 2.1 KHZ, 6db down; 4.2 MHZ, 60 db. **Image Rejection: ≤40db. Power Output:** 3.4 to 15 MHZ 100 watts PEP, 50 ohms; 15 to 25 MHZ, 90 watts PEP, 50 ohms; 25 to 30 MHZ 80 watts PEP, 50 ohms. **Plate Input:** 175 watts PEP on SSB; 160 watts CW **Size:** 14.75" × 7.75"H × 14"D. **Weight:** 18 lbs., 3 oz. **Price: $795.00**

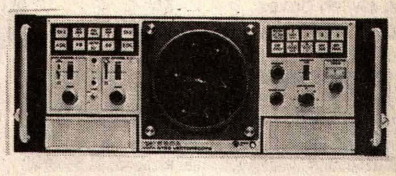


MODEL HP 180A

Oscilloscope: Mil Spec AN/USM-281A, 8 x 10 CM display, 100 MHz response which accepts standard 1800 series Plug-Ins. Includes Vertical Plug In: 1801A (PL-1186), frequency BW 50 MHz, maximum sensitivity 5mV/DIV. Horizontal Plug-In: 1821A (PL-1187), triggering to 100 MHz, minimum sweeptime 100 NS/DIV, has delayed sweep capacity.
Price: $250.00

GENERAL MICROWAVE 476 THERMALELECTRIC POWER METER

With type 4240A power head.
Power range: 30n watts to 10m W (−45 to +10 dBm).
Frequency Range: 0.01 to 18 GHz
VSWR: 1.5 from 0.01 to 0.015 GHZ
1.35 from 0.015 to 10 GHZ
1.6 from 10 GHZ to 18 GHZ
Connector: Type N
Meter Size: 4.5 inches
Accuracy: ±1% of full scale on all ranges
Built in 10 KHZ calibration signal. **Power Requirements:** 115V/230V, 50-1000HZ @ 5 watts.
Size: 6.1"H × 5.1"W × 11.3"D.
Weight: 7 lbs.
Price: $350.00



TEKTRONIX 520A DUAL CHANNEL VECTORSCOPE

Measures: Luminance Amplitude, Chrominance Amplitude and Phase differential phase and gain (1% accuracy). CRT accuracy of 12.5° and 2.5 IRE units for vector and amplitude measurements. Internal calibrated phase shifter with a range of 30°, with accuracy of 0.5°. Color demodulation in I, Q or R-Y axis. Vertical internal test signal observation. **Video inputs:** 75 ohms, 2 each, >46dB, return loss to 5MHZ. Swept measurements of Y, R, G, B. **Input power:** 90 to 136 VAC or 180 to 272 VAC, 47 to G3Hz, 95 watts. **Size:** 19"W × 7.0"H × 19.8"D. **Weight:** 33 lbs. **Price: $1495.00**

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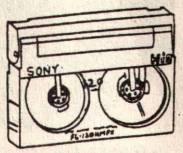
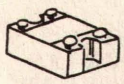
8 MM SONY VIDEO CASSETTES (USED)



Sony 120 minute, Hi8 metal particle video cassettes. Used and bulk erased. In new condition these high quality cassettes would sell for considerably more. A great deal for 8mm camcorder users. **CAT# VCU-8**
$2.50 each • 5 for $11.00

Solid State RELAY For D.C. Loads



Opto 22 # DC60S3
Control Voltage: 3-32 Vdc
Load: 3 amps @ 4-60 Vdc
(5 amp surge). This Solid State relay is designed to switch D.C. loads. 2.25" X 1.75" X 0.91" high. Epoxy block with metal base. Screw terminals.
CAT# SSRLY-12U $9.50 each

General Use A.C. Switch

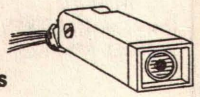
Leviton. Standard SPST, 15 amp AC switch. Brown. Screw terminals. Fits all standard wall switch boxes.
CAT# ETS-1
2 for $1.00

12 VDC 300 ma. Wall Transformer

New 12 Vdc, 300 ma wall transformers. Cord terminates to bare wire. Large quantity available.
CAT# DCTX-1231 $2.25 each
100 for $20.00 • 1000 for $185.00

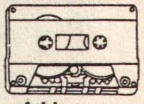
PHOTOELECTRIC SWITCHES

Adalet model 57010. Turn lights, signs and other electrical devices on at dark and off at dusk. Built-in delay to prevent switching caused by sudden change in ambient light. 120 Vac, 300 watts. UL listed. 0.65" diameter threaded bushing for mounting. Threaded plastic nut. 9" long pigtail leads. **CAT# PES-1** $3.00 each



Adalet model 57000. Operates the same as the unit left, but this one is built-into an adjustable swivel mount to facilitate aiming the device. Base of swivel is threaded 3/4" threaded bushing designed to screw into standard electrical knock-out box.
CAT# PES-2 $4.00 each

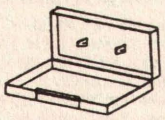
HIGHEST QUALITY METAL CASSETTES (Erased)



Premium quality metal tape in C-60 cassettes (30 or more per side). One of the finest "brand-name" tapes on the market, in durable, clear plastic transport mechanisms. Recorded and bulk erased, the record-protect tabs have been removed and therefore, need to be taped over to re-record. Audiophiles will appreciate the wide dynamic range of this tape. If your cassette deck has a "metal" setting you will hear the difference. A real bargain!

CAT# C-600M **$1.25 each**
10 for $10.00

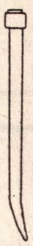
CASSETTE STORAGE CASE



Black, unbreakable plastic audio cassette storage case.
CAT# CBOX 5 for $1.00 • 100 for $15.00

CABLE TIES

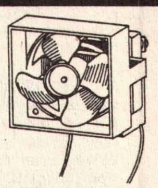
Cat#	Approx. Length	Min. Tensil Strength	Color	Max. Bundle Dia.	10	100	1000
TR-400	4"	18 lbs	neutral	15/16"	.30	$2.50	$15.00
TR-400B	4"	18 lbs	black	15/16"	.35	$3.00	$17.50
TR-600	6"	30 lbs	neutral	1 1/2"	.50	$4.00	$30.00
TR-600B	6"	30 lbs	black	1 1/2"	.50	$4.00	$30.00
TR-800	8"	50 lbs	neutral	1 3/4"	.60	$5.00	$40.00
TR-800B	8"	50 lbs	black	1 3/4"	.70	$6.00	$50.00
TR-1100	11"	50 lbs	neutral	3"	.70	$6.00	$50.00
TR-1100B	11"	50 lbs	black	3"	.80	$7.00	$60.00
TR-1500	15"	50 lbs	neutral	4"	$1.00	$8.00	$70.00
Heavy-duty 15" cable tie.							
TR-1500HD	15"	120 lbs	neutral	4 1/4"	$1.50	$12.00	$100.00



DYNAMIC MICROPHONE

Good quality dynamic mike. Brushed aluminum with black trim. 0.93" dia. X 4.42" long. 5' cord with 3.5mm mini-plug.
CAT# MIKE-12 $1.50 each

115 VAC COOLING FAN



Open frame cooling fan with 3.25" square plastic cage. Mounting holes on 2.75" centers.
CAT# CF-16
$4.00 each

15" POWER CORD

15" Belden SVT 18/3 black detachable power cord. 3 prong right angle grounded AC plug one end, IEC socket other end
CAT# LCAC-15 $1.25 each 10 for $1.00

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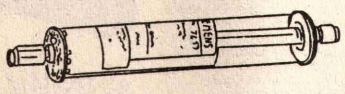
LASER COMPONENTS

WARNING!!!

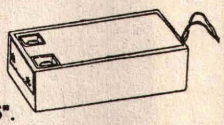
DO NOT BUY these products if you do not know the dangers of laser energy! We are selling components only. If assembled into a complete laser system, they must comply with all C.D.R.H. regulations.

Laser Tube



Siemens # LGR 7659
1 mW helium-neon laser tube.
22.5 mm diameter X 146 mm long. 1.7 mrad beam divergence. 7 kV start voltage. 1kV operating voltage. 3.5 mA current.
CAT# LT-1 $25.00 each

Laser Power Supply



Epoxy encapsulated power supply for up to 2 mW lasers.
4 1/2" X 1 1/2" X 1 7/16".
Input: 9 Vdc @ 1 amp
Output starting voltage: 7 to 8 kV
Operating voltage: 1.1 to 1.5 kV
Operating current: 4 to 5 mA
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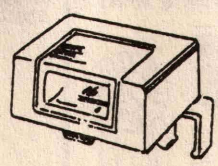

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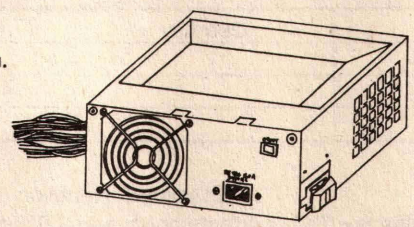

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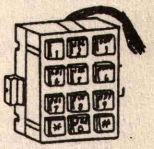

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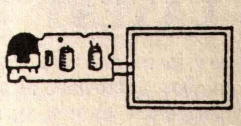

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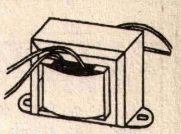

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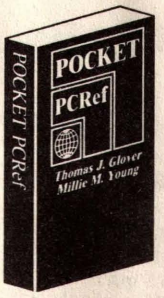

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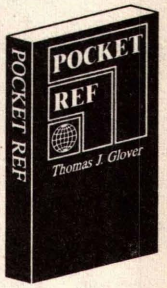

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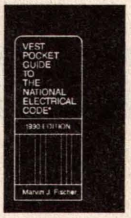

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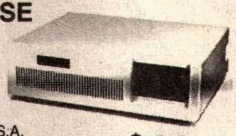

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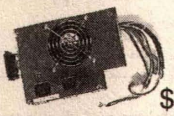

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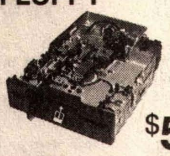

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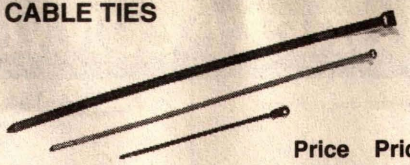

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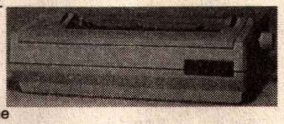

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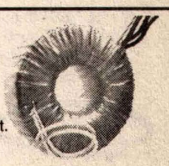

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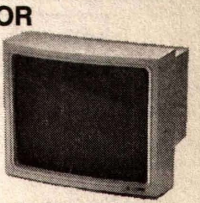

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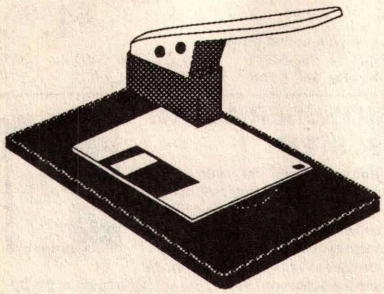

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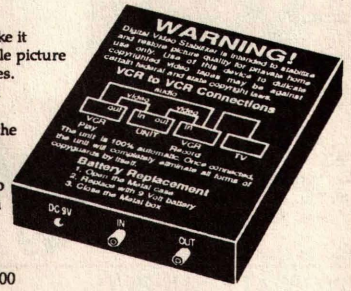

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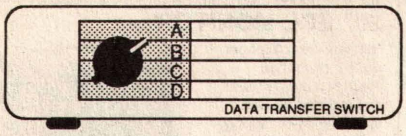

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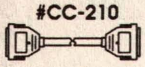

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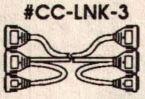

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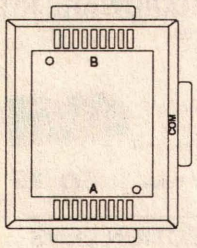
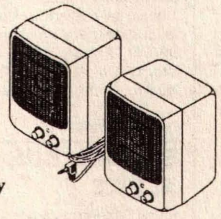


Use one printer with two computers
Specify Serial or Parallel
Safe for HP Laser jet
No power supply required
DB-25 Connectors I/O

#DS-201

$25 each

Amplified Stereo Speaker System

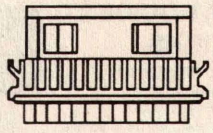


built-in stereo amplifier
linear volume control
bass booster switch
requires:
4 x 1.5v batteries or
external 6v power supply
styles may vary

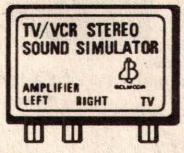
#TM-172
$24 each 10 up **$22** each

486/AT CPU Heat Sink with Fan

clips to chip
easy hook-up to power!



#TM-FAN-2
$22 each 10 up **$20** each



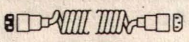
TV/VCR Stereo Sound Simulator

simulates stereo sound
from a mono source
better that using a "Y" cable

.50¢ each 10 up **.40¢** each

Coiled Power Extension

6 ft Belden, Great for movable
CPU's / Monitors / Printers

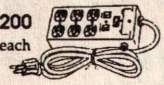


#CC-PWXC
$2 each 20 up **$1.50** each

Surge Protector

6 Outlet Power/Modem
EMI/RFI protector w/indicator.

#TM-200
$12 each



P/S2 Keyboard Adapter

Mini 6 pin Male
to 5 pin Female
or reverse

#CA-200
#CA-201 **$3** each

Credit Cards: Accepted 24 hours a day 7 days a week by FAX.
Company Check or Money Orders: You must include $3.50 shipping and your telephone number. California residents add 8.25% sales tax.

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Statpower's use of modern high frequency switching power supply technology and the latest power MOSFETs make PROwatt inverters more compact and versatile than other inverters based on older 60 Hz transformers and bipolar transistors. Digital circuitry under quartz crystal control precisely regulates the output voltage and frequency. Unlike square-wave inverters, PROwatt inverters are suitable for most loads including sensitive electronic equipment and inductive loads.

PROwatt inverters are affordable and come loaded with handy features. Whether you're at work or at play, Statpower inverters are made for people on the go.

PROwatt inverters are ideal for...

- **Computer and test equipment** - no need for bulky battery packs or 12V based equipment
- **Power tools, soldering irons, lighting** - use the tools of your trade while doing field service work
- **Televisions, VCRs, video games** - enjoy the comforts of home while you're on the road
- **Chargers for camcorders, laptops, and cellular phones** - Operate these products directly, or charge while you drive

Compare these features against the competition...

- **Small size and light weight**
- **Precisely regulated output voltage and frequency**
- **Low no-load current draws and 90% efficiency**
- **Automatic protection against overloads and overheating**
- **Automatic low battery alarm and shutdown**
- **High surge capability for difficult-to-start loads**
- **Modified sine wave output waveform**

SPECIFICATIONS

PROwatt	125	250	800	1500
Continuous Power	125W	200W	800W	1500W
10 Minute Rating	150W	300W	1000W	2000W
Dimensions	1.5"x4.5"x4.5"	1.5"x4.5"x6"	3"x9"x10"	3"x9"x15"
Weight	18 oz.	20 oz.	5 lbs.	8 lbs.
Price	$ 129.	$ 199.	$499.	$849.

List prices are quoted in US Dollars. Actual dealer prices may vary.

To order, call or fax one of these Statpower distributors today!

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S. California/Southwest
All Electronics Corp., Van Nuys, CA
Tel: (800) 826-5432 Fax: (818) 781-2653

South/Texas
R&R Electronic Supply Co., Lubbock, TX
Tel: (800) 299-7000 Fax: (806) 763-6000

Southeast
Electronic Equipment Co. Inc., Miami, FL
Tel: (800) 327-1526 Fax: (305) 871-3736

Midwest
Laco Electronics Inc., Mt. Vernon, IL
Tel: (800)642-4960 Fax: (618) 242-7983

Northeast
Barbey Electronics, Reading, PA
Tel: (215) 376-7451 Fax: (215) 372-8622

Midsouth
Radio Supply Inc., Oklahoma City, OK
Tel: (800) 727-7247 Fax: (405) 232-8598

Canada
RP Electronic Components Ltd.,
Vancouver, BC
Tel: (604) 738-6722 Fax: (604)738-3002

Manufactured by

STATPOWER TECHNOLOGIES CORP.

7725 Lougheed Hwy., Burnaby, BC V5A 4V8 Tel: (604) 420-1585 Fax: (604) 420-1591

CIRCLE 298 ON FREE INFORMATION CARD

MCM ELECTRONICS

YOUR SOURCE FOR SERVICE AND COMPONENT KITS

Whether in the shop, truck or home these kits are high-quality and neatly organized so you'll always have the right part at your fingertips.

Prices Effective March 4 thru May 4, 1993.

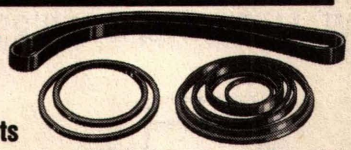
SAVE $95

VCR Pinch Roller Kit

Save over 48% off list prices when you purchase this kit! Kit contains the most popular pinch roller replacements used to repair name brand VCRs such as Sony, Sharp, Fisher and more.

#102-016..... $99.95 (kit)

NEW



VCR Belt Kits

MCM has three brand new VCR Belt Kits to offer you! These kits contain the most popular belts used to repair VCRs. Purchase these kits and you'll not only save valuable repair time, but money too. Call and order today!

Order #	Type	Savings Over List Prices	Price (kit)
102-020	VCR Belt Kits	$9.00	$34.90
102-021	Flat	18.00	39.95
102-022	Square	13.00	34.95

Zener Diode Kit

SAVE OVER $4

Save 23% off list price when you purchase this kit!

#102-003..... $19.95 (kit)

SAVE $10

IC Protector Kit

Don't risk a sell-out on this IC Protector Kit that is now 55% off list prices! Chock full of original IC protectors found when servicing most VCRs and camcorders. Hurry and stock-up today!

#102-006
Reg... $39.95 (kit) Sale $29.95 (kit)

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This kit contains 320 of the most frequently replaced idler tires used to service VCRs today! Durable steel kit case and comprehensive cross reference combine to make this a great value.

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RES-05

CIRCLE 293 ON FREE INFORMATION CARD

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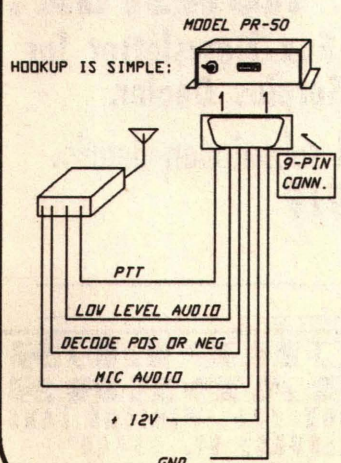
PR-50 SIMPLEX VOICE REPEATER VILL VORK AS A VEHICULAR REPEATER OR A STAND-ALONE SIMPLEX REPEATER. SIMPLY CONNECT THIS UNIT TO YOUR EXISTING MOBILE RADIO OR BASE UNIT. GREAT FOR HILLTOP OR FIELD APPLICATIONS.

DRAVS ONLY 50mA OF CURRENT.

149.00



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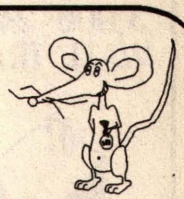

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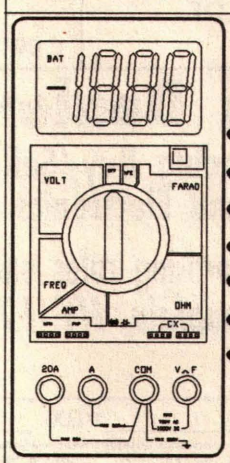
HOURS: NOON TO 6:00 MON-FRI 9:00-1:00 SAT.



DM3050 METER

MEASURES:
- •FREQUENCY
- •CAPACITANCE
- •RESISTANCE
- •AMPS
- •HFE
- •VOLTS
- •CONTINUITY

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AFFORD A SCOPE!!!!!!

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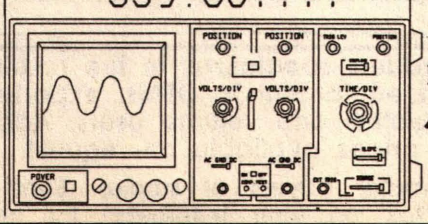
339.00!!!!



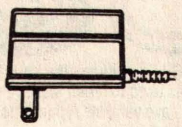
GIANT SOLAR PANEL

3/4 AMP
14.4V
12x36 IN.
44.00 EA!

CIRCLE 261 ON FREE INFORMATION CARD

SURPLUS

10,000 12VDC/300MA WALL TRANSFORMERS



WHITE

$1.48EA/1000 LOT

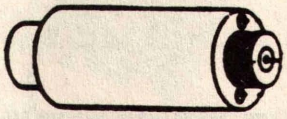
CR922

20,000 USED NORTHERN TELECOM 2500 PHONES

$3.90 EA/LOT DEAL

CR930

ATTENTION: DEALERS 1,000 SNOOPER STOPPERS

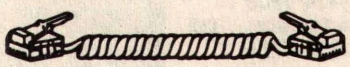


PRECISION MADE TO CABLE TV CO SPEC C/W DETAILED LITERATURE

$9 EA/100 LOT

CR896

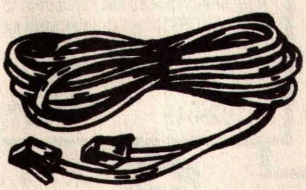
20,000 15' MODULAR HANDSET CORDS



24¢ EA FOR THE LOT

CR758

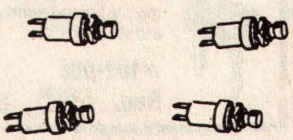
3,000 SIX CONDUCTOR TELEPHONE CORDS



38¢ EA/1000

CR122

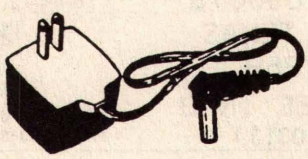
3,500 MINI MOMENTARY PB RED CAP SWITCHES



25¢ EA/1000

DL012

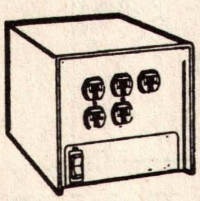
3,000 24VDC/400MA WALL TRANSFORMERS



$2.38EA/1000 LOT

CR915

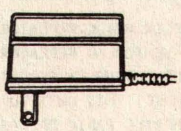
1,300 220VAC/110VAC STEPDOWN TRANSFORMERS



$34 EA/500 LOT

CR879

20,000 12VDC/500MA WALL TRANSFORMERS



WHITE

$1.75 EA/1000

CR919

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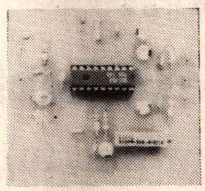
DC KITS

TOLL FREE ORDER HOT LINE 1-800-423-0070

KIT CORNER

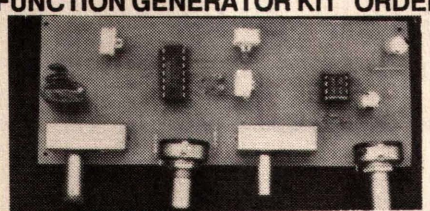
WIRELESS FM STEREO BROADCASTER KIT

CAT. NO. SFM-II $19.95



DC'S all new FM Stereo Transmitter Kit is based upon the unique BA1404 Stereo Broadcaster Integrated Circuit that includes all the complex circuitry to generate the stereo signal. The kit includes the new special IC, a 38 KHz crystal, circuit board, and all the small components . This facinating project will provide many hours of enjoyment as you re-broadcast your CD/VCR/Cassette or stereo broadcasts from your satellite system thru your high-quality FM home or auto stereo system.

FUNCTION GENERATOR KIT ORDER FG2 KIT $19.95



A great project to enhance your bench. This handy little function generator has a built-in buffer amplifier, a 3-decade range selector switch that covers 15 hZ to 25 khZ, output level control and function switch to select sine, square, or triangle.

ICL7106 EV KIT LCD DIGITAL PANEL METER NOW $24.95

The ICL7106 EV Kit is based upon a 3-1/2 digit A/D converter that includes all the circuitry to build a digital panel meter. Operates from a 9-v battery. Includes LCD, 7106 IC, circuit board and small parts. Builder must add resistors to expand to multi-meter

POWER SUPPLY KIT PS-1 $16.99

Output of this power supply is continiously adjustable from 1.2 to 25V DC . The LM317T voltage regulator provides excellent regulation and ripple rejection. Includes a 1 A transformer, PC board, LM317T, 2 binding posts, and all small parts.

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MAKE CIRCUIT BOARDS THE NEW, EASY WAY

WITH TEC-200 FILM JUST 3 EASY STEPS

1. Copy circuit pattern on TEC-200 film using any plain paper copier.
2. Iron film onto copper clad board.
3. Peel off film and etch.

ORDER TEC-200-10 FOR TEN

PC BOARD SUPPLIES
Copper clad boards for use with TEC-200

22-250	3 x 6	$1.62
P1-36	3 X 6	2.03
22-260	4 X 6	2.27
22-261	6 X 6	2.88
22-263	6 X 9	4.08

POSITIVE PRESENSITIZED PC BOARDS

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22-336	6 X 6	7.60
22-338	6 X 9	9.63

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LM733	.99	74C00N	.29	CD4053	.50
LM7805	.50	LM7812	.50	LM7905	.50
18 Uh CHOKE	.39	3.58 MHz	1.00		

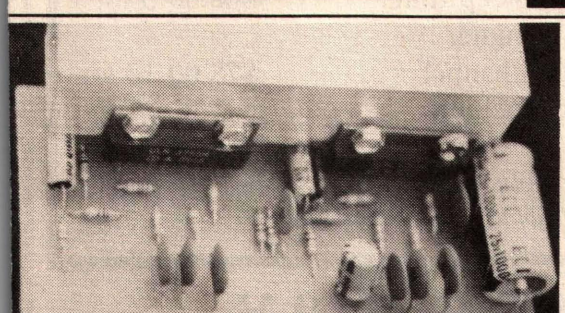
ORDER ABOVE ITEMS DIRECT FROM THIS PAGE

MORE KITS

3 DIGIT LED DVM ONLY 3" X 3" READS 0 TO 100 V DC ORDER DVM3 $19.95
FM WIRELESS BROADCASTER FMI $ 9.95
8038 FUNCTION GEN. KIT FGI $ 9.50
SEQUENCER PROJECT SEQKIT $ 9.50

CHRISTMAS TREE PROJECT

Build this unique seasonal project and have an unusual converstion piece. Powered by two D cells, 17 LEDs flash in a seemingly random fashon. Kit includes everything except batteries. ORDER XMASKIT $16.95



70-WATT STEREO POWER AMP

35 WATTS PER CHANNEL

Now you can boos ylour low power car stereo with the new PM-35 module kit. Each module can provide up to 35 watts per channel whil operating from the vehicle's battery into a 4 ohm speaker system. New hi-tech power op-amps are used in a unique circuit to increase voltage swings, thus more power.Additional modules can be used to increase power to 100 or 200 watts/channel.

ORDER PM-35 KIT $19.95

UNIQUE IC's

NE602	$2.00
UGN3013	.98
ULN2429	1.75
ZN414	2.00
XR2206CP	4.75
XR2212CP	4.75
MAX232	5.40
ULN3330	1.50
ICL8038	3.85
ICM7226BIPL	23.50

DC ELECTRONICS

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400 MHZ 60 Channel $59.95 each

$55.00 each - 5 lot • $50.00 each - 10 lot
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New Zenith SSAVI
Power Supplies Available

MTS Stereo Processors for SSAVI
Available - Works with any Cable Converter

VIEWSTAR IS HERE

MXC-2520-525 MHZ remote volume	
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NEW "North Coast"

'Excel' 66 channel remote	$99.95 ea.
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Selectable Twinline A/B Select Optional

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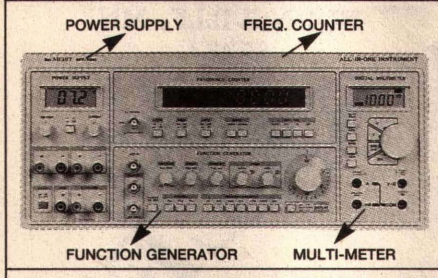


MT-100

Reg. $595.

$395.00

Four Instruments in One Instrument

1 Function Generator
- Sine, Square, Triangle, Pulse, Scewed Sine, Ramp, TTL
- 0.02 Hz ~ 2MHz

2 Frequency Counter
- 8 Digit LCD
- 1 Hz ~ 100MHz
- ± (1 Hz + 1 dgt. + Time Base Error)

3 Power Supply
- 3-1/2 Digit LCD
- Triple output: #1. 0~50V, 0.5A MAX #2. 15V, 1A #3. 5V, 2A

4 Digital Multimeter
- 3-1/2 Digit LCD
- DCV, ACV, Ω, DCA, ACA
- ± (0.5% + 2 dgts)

FG-150

Reg. $395. **$225.00**

2MHz Sweep / Function Generator w/Built-in Frequency Counter

- 4 Digit LCD Display
- 0.2 Hz ~ 2.0 MHz
- Sine, Square, Triangle, Pulse, Scewed Sine, Ramp, TTL
- Linear or Logarithmic Sweep
- Variable DC Offset Control
- 10 MHz Frequency Counter

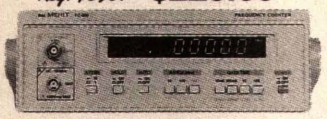
FC-190 (100MHz)

Reg. $295. **$149.00**

FC-200 (1.0GHz)

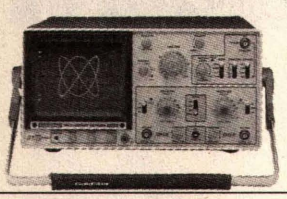
Reg. $395. **$225.00**

High Resolution Frequency Counter



- 1.0 Hz ~ 1.0 GHz
- 8 Digit LCD Display
- Auto to Manual Range
- Measured Value Hold
- 4 Selectable Gate Times
- Below 20mV Input Sensitivity
- 1mΩ ~ 50Ω Input Impedance
- 10:1 Input Switchable Attenuator

GoldStar Oscilloscopes

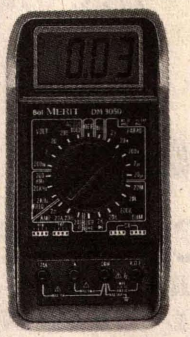


OS-9020A. 20MHz Dual, Econo
Reg. $495. **$345.00**

OS-7020A. 20MHz Dual
Reg. $595. **$375.00**

OS-9020G. 20MHz Dual/Func. G
Reg. $695. **$425.00**

OS-9040D. 40MHz Dual
Reg. $795. **$545.00**



DM3000

Reg. $69.

$44.00

DM3050

Reg. $99.

$54.00

DM3100

Reg. $99.

$54.00

Multi-Function w/Holster

- 3-1/2 Digit
- 1.5" Big LCD
- Heavy Duty, 20A
- Capacitance
- TR-hFE
- Diode
- Low Battery Mark
- Over Range Mark
- Protective Holster
- Tilt Stand

DM3050 Only
- Frequency
- Continuity Beeper

DM3100 Only
- Temperature w/ Optional Probe
- Continuity Beeper

DM3200

Reg. $99.

$54.00

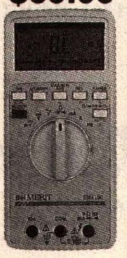
3200 Count w/Bargraph

- Auto & Manual
- 3-1/2 Digit
- 32 Seg. Bargraph
- Diode Test
- Continuity Beeper
- Auto Power Off
- Low Battery Mark
- Over Range Mark
- Optional Holster

DM4100

Reg. $129.

$69.00



4000 Count w/Bargraph

- Auto & Manual
- 3-3/4 Digit
- 40 Seg. Bargraph
- Data Hold
- Min / Max
- Frequency Test
- Relative & Memory
- Diode
- Continuity
- Auto Power Off
- Optional Holster

DM80

Reg. $49.

$34.00

Credit Card Size w/Bargraph

- 3200 Count
- 32 Seg. Bargraph
- Auto & Manual
- Auto Power Off
- DCV, ACV, Ω
- Data Hold
- Continuity Beeper
- Plastic Case Included

DM90

Reg. $59.

$34.00

Pencil Type w/Logic

- 3-1/2 Digit
- Auto & Manual Ranging
- DCV, ACV, ACA, DCA, Ω
- Logic CMOS/TTL
- Data Hold
- Diode
- Continuity Beeper
- Case Included

DM20T

Manual Ranging w/Temperature

Reg. $49.

$29.00

- 3-1/2 Digit
- 20 Ranges / 6 Functions
- DCV, ACV, DCA, Ω
- Diode
- Auto Polarity
- Temperature w/ Optional Probe

DM30S

Auto Ranging w/Memory Mode

Reg. $59.

$39.00

- 3-1/2 Digit
- Data Hold
- Memory Mode
- Diode
- Continuity Beeper
- Low Battery Mark
- Case Included

Oscilloscope Probes Switch Selectable X1 / X10

HP-9060, 60MHz
Reg. $29. **$15.00**

HP-9150, 150MHz
Reg. $49. **$22.00**

HP-9250, 250MHz
Reg. $59. **$29.00**

DM10S

Reg. $29.

$19.00

Compact w/Carrying Case

- 3-1/2 Digit
- 17 Ranges / 6 Functions
- DCV, ACV, DCA, Ω
- Diode
- Battery Checker
- Auto Polarity

AM20I

Reg. $39.

$24.00

General Purpose Analog Meter

- 20,000 Ω/V
- 21 Ranges / 6 Functions
- 10A DC
- Battery Checker
- Continuity Beeper
- Ohm Adjust

DA400

400 Amp AC Digital Clamp-On

Reg. $89.

$45.00

- 3-1/2 Digit LCD
- Auto Ranging
- Data Hold
- Continuity Beeper
- Over Range Mark
- Case Included

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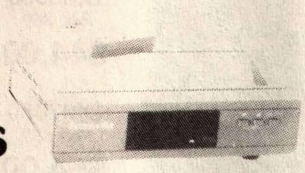

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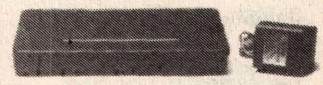
SB - 3 OR 2	$ 55.00	$ 43.00	$38.00	CALL
SP-200 (SPECIAL PIO)	$145.00	$135.00	CALL	CALL
*OAK N-12 (WITH VARI-SYNC)	$ 54.00	$ 49.00	$39.00	$35.00
*HAMLIN 1200 CH. 3	$ 65.00	$ 46.00	$38.00	$30.00



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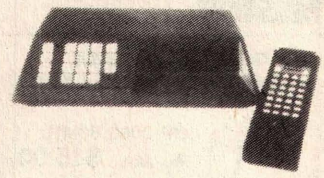
PANASONIC TZPC 145	$80.00	$75.00	$70.00	CALL
T P550 (550 MHZ W/PARENTAL)	$80.00	$75.00	$70.00	CALL
*JERROLD DQN-5	$80.00	$70.00	CALL	CALL
*JERROLD DQN-V7 w/volume	$85.00	$75.00	CALL	CALL
*JERROLD DRZ-450	$59.00	$49.00	$45.00	CALL
*SYLVANIA TEXSCAN 4040 (CH. 2, 3 OR 4)	$55.00	$45.00	$36.00	CALL

*REFURBISHED AS NEW. CONVERTERS AVAILABLE IN CHANNEL 2 OR 3.

COMBINATION UNITS

*SCIENTIFIC ATLANTA	CALL FOR AVAILABILITY AND PRICING			
*ZENITH MODELS	CALL FOR AVAILABILITY AND PRICING			
JERROLD BASEBAND	$329.00	$299.00	CALL	CALL
JERROLD DPV7-212	$249.00	$239.00	CALL	CALL
*JERROLD DP5-DPV5	CALL FOR AVAILABILITY AND PRICING			
*JERROLD DRX-3DIC	$119.00	$109.00	CALL	CALL
*JERROLD DRZ-3DIC	$124.00	$114.00	CALL	CALL
*SYLVANIA TEXSCAN 4040-DIC (CH. 2 OR 3)	$ 79.00	$ 74.00	CALL	CALL
*OAK M35B (WITH VARI-SYNC)	$ 49.00	$ 44.00	CALL	CALL
*OAK RTC56	$145.00	$125.00	CALL	CALL



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OTHER PRODUCTS AVAILABLE: REMOTES: JERROLD, PANASONIC, HAMLIN, TOCOM, SCIENTIFIC ATLANTA. INTERFERENCE FILTERS: CHANNELS 2 OR 3 / VIDEO TAPE ENHANCERS. AC ADAPTERS: 12 & 18 VOLT / ADULT INSULT BOXES / MORE. FULL SERVICE TECHNICAL SUPPORT.

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CIRCLE 300 ON FREE INFORMATION CARD

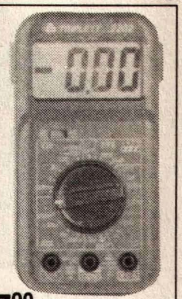
Parts Express International Inc.

Grill Guides

Ball and socket type grill guides for attaching speaker grill to cabinet. To use, simply drill the appropriate size holes in cabinet and grill frame. 12 pair per package.

#RJ-260-367 $1.80 Per Pkg

Triplett DMM



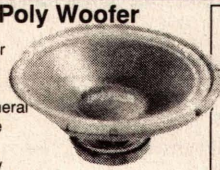
The Triplett model 2202 digital multimeter is a full function DMM with built-in transistor and battery testers. Large, easy to read LCD display. Rotary switch for easy one hand function selection. The test leads conveniently attach to meter so they are always in reach. Test leads, manual, and carrying case included.

Specifications:

*DC Voltage		*AC Current	
Ranges	200mV, 2V, 20V, 200V, 1000V	Ranges	200mA, 2mA, 20mA, 200mA, 10A
Resolution	0.1mV, 1mV, 10mV, 1V	Resolution	Same as DC current
Accuracy	0.5% on 200mV, 0.8% on all others	Accuracy	2% on 10A, 1.2% on all other ranges
*AC Voltages		*Resistance	
Ranges	200mV, 2V, 20V, 200V, 750V	Ranges	200, 2K, 20K, 200K, 2M, 20M ohm
Resolution	Same as DC voltage	Resolution	0.1, 1, 10, 100, 1K, 10K ohm
Accuracy	1.2% on all ranges	*Continuity	
*DC Current		Resistance	Audible beep below 40 ohm
Ranges	200uA, 2mA, 20mA, 200mA, 10A	Resolution	1 ohm
Resolution	0.1uA, 1uA, 10uA, 100uA, 10mA	*Battery	
Accuracy	2% on 10A range, 0.8% on all others	Ranges	1.5V, 9V
		Resolution	1mV, 10mV

#RJ-390-140 $47.00 Each

Pyle 15" Poly Woofer



15" poly woofer with a 60 oz. magnet and 2" voice coil. Mineral filled poly cone with poly foam surround. Poly cone provides proper internal damping to help control cone motion at high power excursion. Power handling: 100 watts RMS, 145 watts max. VAS= 10.9 cu ft., QTS=.53, fs= 30 Hz. Frequency response: 20-3,000 Hz. SPL= 98 dB1W/1M. Impedance: 4 ohm. Net weight: 9-1/2 lbs.

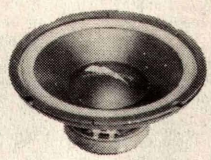
#RJ-292-070 $64.80 Each

Pickering Headphones

We made a special buyout directly from the manufacturer on these super quality personal headphones. 1" dynamic high velocity element with strontium ferrite magnet. Adjustable headband with foam ear cushions. 5 ft. cord to 3.5 mm and 1/4" adaptor included.

#RJ-249-100 $2.49 Each

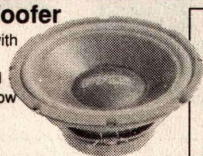
10", Thruster Car Woofer



Heavy duty car woofer capable of handling 175 watts max (125 RMS). 4 ohm impedance. Polymerized paper cone with red poly foam surround. Resonant frequency: 26 Hz. VAS= 5.89, QMS= 4.6, QES= .27, QTS= .26. Frequency response: 30-2,000 Hz. Magnet weight: 38 oz, 2" voice coil. SPL= 92 dB 1W/1M. Net weight: 6 lbs.

#RJ-293-090 $29.95 Each

Pyle 10" Poly Woofer



Long throw poly woofer with poly foam surround for superb low bass. Mineral filled poly cone assures low frequency sound that is smooth, tight, and low in distortion. 2" voice coil, power handling: 85 watts RMS, 130 watts max. fs= 43 Hz. Frequency response: 25-3,000 Hz. SPL= 95 dB 1W/1M. Impedance: 4 ohm. 40 oz. magnet. VAS=1.8 cu ft., QTS= .34, QMS= 10.92, QES= .35. Net weight: 8 lbs.

#RJ-292-030 $45.80 Each

The Loudspeaker Design Cookbook IV

This book describes the "science" of loudspeaker design, however applying it is an "art". Using the information in this book will yield hundreds of possible variations in speaker design, with some subtle and not-so-subtle differences. 1991 copyright, fourth edition. Author: Vance Dickason. 154 pages paperback.

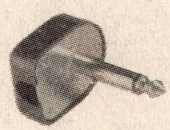
#RJ-500-035 $29.95 Each

Deluxe In-Wall Speakers

Perfect surround speakers. Customize your media room with these super quality, in-wall speaker pairs. Full size 6-1/2" woofer. Heavy duty 1" soft dome tweeter. Built-in crossover. Fits any standard 2 x 4 or larger wall. Retrofit design allows easy installation in new or existing walls. Response: 50-20,000 Hz. 8 ohm impedance. 40 watts RMS, 60 watts maximum. Includes provision for easy 70V/25V transformer mounting. Overall dimensions: 8-1/2" x 12". Net weight: 9 lbs.

#RJ-300-036 List $299.95 $99.95 Pair

Right Angle 1/4" Phone Plug (Mono)



#RJ-099-020 65¢ Each

Honeycomb Tweeter

Unique tweeter with a square diaphragm of honeycomb material. Diaphragm is 1" square. Excellent dispersion. 13/16" voice coil. Frequency response: 2,000-20,000 Hz. Impedance: 8 ohm. Power handling : 25 watts RMS, 40 watts maximum. 4" x 3-1/4". Limited availability. Net weight: 1 lb.

#RJ-279-110 $8.70 Each

High Voltage Cap Kit

This 85 piece kit contains a selection of 250, 350, and 450 volt electrolytic capacitors. 5 pieces each of 1, 2.2, 3.3, 4.7, 6.8, 10, 22uf and 2 pieces each of 33, and 47uf, 250V radial caps. 5 pieces each of 1, 2.2, 3.3, 4.7, 10uf and 2 pieces each of 22, 33uf, 350V radial caps. 5 pieces each of 1, 2.2, 4.7uf and 2 pieces of 10uf, 450V radial caps. Over $62.00 wholesale cost if purchased individually. Net weight: 1 lb.

#RJ-020-950 $49.95 Each

3" x 5" Speaker

Standard radio and TV speaker. 16 ohm impedance. 3 watts maximum power handling. Limited availability.

#RJ-299-115 $1.95 Each

Large Input Terminal

Large input cup with push spring terminals and 4 lug terminal strip on rear. Flush mounted housing measures: 4" x 5-1/2" outside diameter. 4-5/8" x 3-1/16" mounting hole required. Limited availability.

#RJ-269-220 95¢ Each

Fluorescent Work Light

Handy light operates on 120VAC or 12VDC. Puts light where you need it. Extra bright 15 watt tube. 15 foot oil resistant power cord with wall adaptor and cigarette lighter plug. Two hooks provided for hanging. Net weight: 2 lbs.

#RJ-360-490 $18.95 Each

5-1/4", 2-Way Pioneer

5-1/4" paper cone woofer with a 1" post mounted polymer tweeter. 4 ohm impedance. Response: 100-20,000 Hz. Power handling : 35 watts RMS, 50 watts maximum. 2-3/4" mounting depth. Limited availability. Net weight: 2-1/2 lbs.

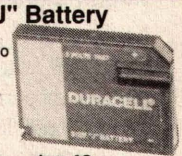
#RJ-269-065 $12.80 Each

Mini Super Tweeter

Super paper cone tweeter with silver mylar dust cap. Impedance: 8 ohm. Power handling capability: 2 watts RMS. 9-1/16" voice coil. 1-1/2" diameter cone with mounting tabs. Mounting holes: 1-7/8" on center. Limited availability.

#RJ-279-120 95¢ Each

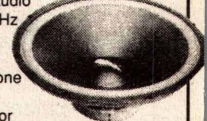
Duracell "J" Battery



Popular TV/stereo remote control battery. Size "J", 6 volt alkaline. Duracell #7K67.

#RJ-140-090 $3.40 Each

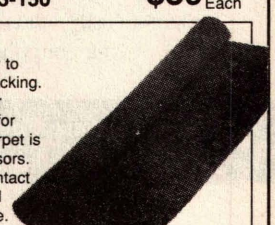
15" Thruster



Super duty, 15" car audio bass driver. Low 25 Hz resonant frequency. Weather resistant polymerized paper cone with red poly foam surround and two color printed dust cap. Power handling capability is 250 watts (170 watts RMS). 2" high temp voice coil with rear vented pole piece. 4 ohm impedance, 50 oz. magnet. Frequency response: 23-2,000 Hz, VAS= 19.04, QMS= 3.96, QES= .21, QTS= .20, SPL= 97.85 dB 1W/1M. Net weight: 11 lbs.

#RJ-293-150 $59.95 Each

Cabinet Carpet



This high quality carpet conforms easily to sharp corners because it has no stiff backing. You can also stretch it to cover irregular shapes. This is the covering of choice for car, stages, and amplifier cabinets. Carpet is strong yet easy to cut with knife or scissors. Adhere with spray adhesive or latex contact cements. Provides protection and good looks. Sold by the linear yard. 54" wide.

#RJ-260-765 (Dark Charcoal)
#RJ-260-767 (Medium Grey)
#RJ-260-768 (Jet Black)

$3.95 Per Linear Yard 36" x 54"

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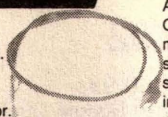
CIRCLE 262 ON FREE INFORMATION CARD

Parts Express International Inc.

Power Cord



Super duty power cord. 14 ga., 3 conductor. 4 ft. length. Limited availability. Black color.

#RJ-119-010 **$1.50 Each**

12VDC, 800mA Adaptor

Fisher Price battery charger. 120VAC input. 12VDC, 9.6W (800mA) output. 6 ft. cord with special connector. Limited availability.

#RJ-120-361 **$4.95 Each**

VCR Parts Assortment

Convenient assortment of clips, washers, springs, and screws. 10 pieces each of 4 sizes of "E" clips, 10 pieces of 2 sizes of retaining rings, 10 pieces of 14 sizes of washers, 2 each of 8 sizes of tension and compression springs and 24 assorted screws. Total of 246 pieces.

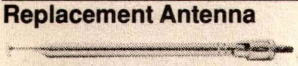
#RJ-430-315 **$6.50 Each**

Speaker Sealing Caulk

Special rubber compound quickly and easily seals speakers into cabinets. Eliminates vibration and air leaks. Sold in 1/4" x 36" strips. Strips are self-adhesive so they stick easily to speaker frame. Limited quantity.

#RJ-269-300 **75¢ Each**

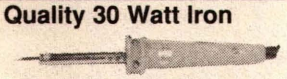
Replacement Antenna



Hinged 7 section antenna. 19" extended, 5-1/4" collapsed. 3/16" threaded base. Excellent antenna for portable radios, TVs, and more.

#RJ-210-200 **50¢ Each**

Quality 30 Watt Iron



Economical 30 watt iron with replaceable tip. Blue plastic handle. 120VAC. A quality iron at a reasonable price. Display packaged.

#RJ-370-010 **$4.90 Each**

Soldering Stand

Convenient weighted soldering iron stand with cleaning sponge. Display boxed.

#RJ-370-020 **$4.95 Each**

Kester Pocket Pack

Perfect tool box solder supply. The wire feeds conveniently from the handy dispenser tube. Pocket clip attached. .031" diameter solder. .5 ounce (approximately 15 feet).

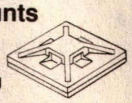
#RJ-370-050 **$1.00 Each**

Isotip Butane Soldering Iron

The ideal soldering iron for field repairs where no AC power is present. Operates for up to 100 minutes of continuous soldering per refill. Uses standard butane (not included) available at most stores. Tip temperature is adjustable up to 1067° F. Iron also comes with a torch attachment which easily screws on in place of the soldering tip. As a torch, one refill will provide up to 1 hour of continuous flame. Temperature is adjustable up to 2372° F. A protective cap with a built-in striker is included. Limited one year warranty.

#RJ-370-235 **$24.95 Each**

Cable Tie Mounts



Package of 10 adhesive back cable tie mounts for securing bundles of wire.

#RJ-080-515 **$1.20 Pkg**

Monitor Power Jack

Standard computer type monitor jack. Limited quantity.

#RJ-090-446 **85¢ Each**

Spray Handle

Fits most paint and cleaner cans. Limited availability.

#RJ-340-371 **75¢ Each**

Pull-Out Radio Carry Case

Super quality nylon bag for storing pull-out radios. Padded construction with adjustable carry strap. Storage pocket will hold up to 5 CD cases. Inside dimensions: 7-1/2" x 2-1/2" x 8".

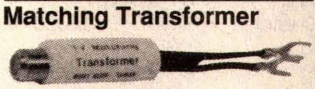
#RJ-265-950 **$10.80 Each**

F-59 Deluxe Connector

Popular connector for cable TV systems. Full attached ferrule for hex crimp. Securely holds RG-59 cable.

#RJ-090-355 **17¢ (50-up)**

Matching Transformer



Adapts 75 ohm coax to 300 ohm twin lead (or vice-versa) at antenna or television. 5-90 MHz UHF/VHF. 3 capacitor, PC board type.

#RJ-180-010 **49¢ Each**

TNC Male Crimp-On

(For RG-59 and RG-62).

#RJ-090-1000 **$1.45 Each**

Technician's Turntable

Turntable to speed repair of VCRs, TVs and more. Lets technician easily turn unit for convenient repair. 20" diameter. White color. Net weight: 5 lbs.

#RJ-360-425 **$19.95 Each**

Outdoor Phone Jack

Heavy duty, diecast aluminum housing withstands the harsh conditions associated with outdoor use. Form gasket under snap shut lid prevents water leakage. Complete with mounting screws. Limited availability.

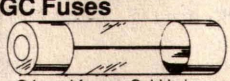
#RJ-150-030 **$2.95 Each**

Universal Video Cable

6 ft. RG-59 cable with a push-on "F" connector to a combination 75 and 300 ohm balun (switchable between 75 and 300 ohm).

#RJ-180-126 **$2.75 Each**

AGC Fuses



San-O brand fuses. Sold in boxes of 100 pieces. Special buyout price. Limited availability and values.

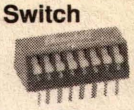
#RJ-070-421 (.5A) **#RJ-070-429 (2.5A)** **$3.95 Per 100**

Mini Headphone Extension

Add 6 feet to your mini headphones. Gives the user added mobility when listening to personal cassette players.

#RJ-240-090 **$1.65 Each**

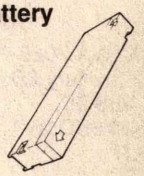
8 Position Dip Switch



Switch type (IE: rocker, slide, toggle) may vary, call.

#RJ-060-134 **60¢ Each**

12V, 2.3AH Camcorder Battery



Popular battery for use with Canon, Chinon, Curtis Mathes, G.E., Magnavox, Minolta, Olympus, Panasonic, J.C. Penny, Pentax, Philco, Quasar, Sears, Sylvania, Teknika and other miscellaneous manufacturers. Dimensions: 7.17" (L) x .94" (W) x 2.42" (H). Weight: 1-1/2 lb.

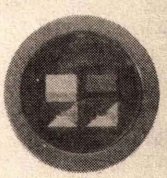
#RJ-140-541 **$41.95 Each**

Velcro Type Fasteners

2, 1" x 2" hook and loop fasteners for attaching almost anything. Great for securing radar detectors to your dash. Each piece has a self adhesive back. Thousands of uses.

#RJ-265-900 **48¢ Pkg**

Pressfit Speaker Terminal



Spring loaded, pushbutton speaker terminal in a round housing. No screws required to fasten; simply drill a hole, apply glue, and press into place.

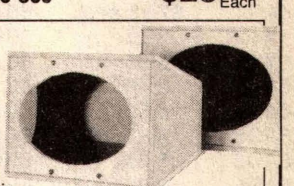
#RJ-260-295 **95¢ Each**

3.5 Amp DC Power Supply

A quality, compact 12VDC power supply. Perfect for testing car stereos, CB equipment, radar detectors and other 12VDC items. Regulated 13.8VDC, 3.5 amp continuous, 3 amp surge. LED power indicator. Binding post outputs. Net weight: 4 lbs.

#RJ-120-500 **$23.80 Each**

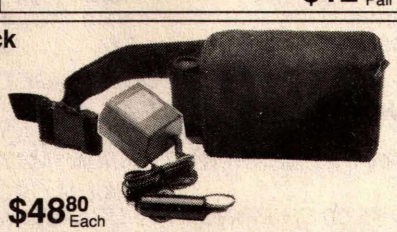
Unfinished 6" x 9" Cabinets



You can paint or finish to your liking. Deep enough for extra large magnet speakers. Flush mount design for rear deck baffle applications. Dimensions: 11-3/4" x 8-1/2" x 6-3/4" x 5" (tapered back). Sold in pairs. Net weight: 9 lbs. per pair.

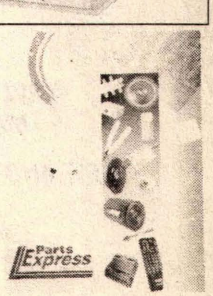
#RJ-260-450 **$12.50 Pair**

Belt Camcorder Battery Pack



Very high current power pack. Will run most camcorders up to 10 times longer than clip-on batteries. 12V, 6.5AH sealed lead acid type battery . Fuse protected with cigarette lighter output. Comes in padded case with quick release belt and UL approved charger. Net weight: 6 lbs.

#RJ-140-603 **$48.80 Each**



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CIRCLE 262 ON FREE INFORMATION CARD

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5U4G	$5.25 each	12 at $4.75 each	25 at $4.25 each	Mesa Boogie Dual Rectifier
12AX7WA/7025	4.35	3.75	3.40	Hartke, Bedrock
6922 (military 6DJ8)	6.75	5.90	5.20	Counterpoint, Convergent
EL84/6BQ5	2.90	2.60	2.25	Peavey, Hughes & Kettner
EL84M/6BQ5WA	5.80	5.20	4.50	Matchless
6V6GT	4.25	3.50	3.20	SLM
6L6GC	3.80	3.25	2.95	
5881/6L6WGC	7.25	6.50	5.95	Fender, Soldano, etc.
811	14.00	12.75	11.50	
813	19.00	16.00	14.50	

SINO, CHINA

2A3	$13.50 each	10 at $12.50 each	25 at $11.50each	100 CALL FOR SPOT QUOTE
6L6GC	4.50	3.90	3.60	" " " " "
12AX7a	3.85	3.25	3.10	" " " " "
12AT7	3.90	3.55	3.40	" " " " "
12AU7	4.10	3.75	3.60	" " " " "
6550	10.00	9.50	9.00	" " " " "
KT88	13.50	12.50	11.50	" " " " "

EI, YUGOSLAVIA

EL34/6CA7	$5.50 each	10 at $4.90 each	25 at $4.50 each	100 CALL FOR SPOT QUOTE
6DJ8	3.15	2.75	2.35	" " " " "
12AT7/ECC81	3.50	3.10	2.75	" " " " "
12AU7/ECC82	3.50	3.10	2.75	" " " " "
12AX7/ECC83	3.15	2.75	2.35	" " " " "

SIEMENS, GERMANY

EL34	$7.25 each	10 at $6.75each	25 at $6.20 each	100 CALL FOR SPOT QUOTE
12AT7/ECC81	4.50	3.90	3.75	" " " " "

TESLA, CZECHOSLOVAKIA

EL34	$7.25 each	10 at $6.75each	25 at $6.20 each	100 CALL FOR SPOT QUOTE
EL34BL (COBALT BLUE)	8.25	7.75	7.20	" " " " "
E83CC/12AX7a	5.90	5.35	4.95	" " " " "

GE, USA

5U4GB	$12.50 each	10 at $11.60 each	6550a	$19.95 each	10 at $18.25 each
6CA7/EL34	14.90	13.50	7025	13.50	11.75
6L6GC	13.90	12.90	7027a	18.90	17.50
6LF6	19.25	17.50	7868	17.00	16.40
12BH7a	9.95	8.75	8417	15.85	14.75
12AT7	7.80	6.30			

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ODD BALL TUBES (MOSTLY USA STOCK)

5AR4	$7.95 each	6BA6	$1.95 each	6J7	$5.50 each	6X5	$3.90 each	6C33C-B	$29.00 each
5V4GT	3.25	6BK11	11.90	6K11	6.90	6X8	3.50	(Power Triode)	
5Y3GT	3.95	6C4	3.50	6SC7	6.90	12AY7	6.50	5749	2.90
6AL5	2.40	6C10	6.90	6SG7	3.50	12AZ7	4.50	(6BA6W industrial)	
6AN8	5.50	6CA4	3.90	6SJ7	2.90	12DW7	11.90	5879	8.50
6AQ5A	4.90	6CG7	6.90	6SK7	2.90	12FQ8	8.00	6189W	4.15
6AQ8	5.85	6EU7	11.80	6SL7	3.95	OA2	3.75	(12AU7W industrial)	
6AS7	3.90	6FH8	12.50	6SN7	2.50	OA3	2.25	6267/EF86	3.20
6AU6	2.25	6GW8	6.90	6U10	4.90	OB2	2.25	6973	14.90
6AX5	4.90	6J5	4.50	6X4	3.90	OC3	3.75	7199	17.80

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CIRCLE 258 ON FREE INFORMATION CARD

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		5	10
NEW	PANASONIC-145 CONVERTER	$62	$59
NEW	TVT-3 DIGITAL TRIBI ADD-ON For most Jerrold systems	51	48
NEW	SCIENTIFIC ATLANTA 8580-338 Converter/Descrambler	CALL	CALL
NEW	SCIENTIFIC ATLANTA 8590	CALL	CALL
REFUR	JERROLD STARCOM 6 (DPV5) Converter/Descrambler	CALL	CALL
REFUR	HAMLIN 6600 or 6000-3-M MLD1200 Built-In Converter/Descrambler	65	55
	HAMLIN-MLD-1200-2	25	20
REFUR	JERROLD DRX-3-DIC Built-In SB-3	89	79
NEW	PIONEER Add-on For all Pioneer Systems	100	95
NEW	SCIENTIFIC ATLANTA Add-on For 8580 Systems	90	85
NEW	JERROLD STAR 7 Add-on	90	85

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This Red Orange Matrix Can Be Stacked Horizontally. Choice of Two Matrix Orientation-Cathode Column, Anode Row. Great For "Moving Message" Signs.
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LS04	.14	LS125	.30	LS245	.55
LS05	.14	LS126	.35	LS251	.45
LS08	.14	LS132	.35	LS253	.40
LS09	.14	LS133	.25	LS257	.35
LS10	.14	LS136	.28	LS258	.45
LS11	.14	LS138	.35	LS259	1.00
LS12	.20	LS139	.35	LS260	.40
LS13	.25	LS145	.75	LS266	.30
LS14	.30	LS148	.35	LS273	.75
LS15	.20	LS151	.35	LS279	.30
LS20	.14	LS153	.35	LS280	.80
LS21	.16	LS154	.85	LS283	.35
LS22	.16	LS155	.50	LS290	.70
LS26	.14	LS156	.42	LS293	.50
LS27	.20	LS157	.30	LS298	.65
LS28	.15	LS158	.25	LS299	1.00
LS30	.14	LS160	.25	LS322	1.30
LS32	.16	LS161	.35	LS323	2.25
LS33	.25	LS162	.45	LS348	.75
LS37	.24	LS163	.36	LS353	1.00
LS38	.24	LS164	.45	LS357	.80
LS42	.35	LS165	.60	LS363	.75
LS51	.15	LS166	.75	LS364	.75
LS54	.20	LS169	.90	LS365	.30
LS55	.20	LS170	.45	LS366	.28
LS73	.33	LS173	.60	LS367	.35
LS74	.22	LS174	.35	LS368	.30
LS75	.25	LS175	.35	LS373	.50
LS83	.30	LS181	1.25	LS374	.45
LS85	.45	LS191	.45	LS375	.35
LS86	.20	LS192	.65	LS377	.75
LS90	.35	LS193	.65	LS378	.80
LS92	.30	LS194	.40	LS390	.80
LS93	.25	LS195	.52	LS393	.75
LS95	.30	LS196	.55	LS399	1.00
LS96	.33	LS197	.75	LS541	1.20
LS107	.28	LS221	.50	LS645	.75
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5087 Generator	2.00
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Try The 1st Truly Low Cost LAN

- Connect 2 or 3 PCs, XTs, ATs
- Uses serial ports and 5 wire cable
- Runs at 115 K baud
- Runs in background, totally transparent
- Share any device, any file, any time
- Needs only 14K of ram

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  - Parallel Speed: 8000(XT)-29000(AT) bytes per second
  - ARCNET Speed: 40000 plus bytes per second
- Use any PC/XT/AT/386 mix, even laptops and PS/2 machines
  - Connect up to 254 computers, can mix connection methods (Serial, Parallel, Arcnet)
- DOS File and Record locking support
- Share any device, any file, any program
- Runs in the background, totally transparent
- Low memory overhead
  - Typically only 28K is needed, but will vary with various setups
- Works with most software, including DBASE III, Microsoft
  - WORD, LOTUS 123, Windows 3, AUTOCAD, Word Perfect, all compilers, GWBASIC, and, in fact, most anything!
- Works with DOS 2.0 to DOS 5.0 and DR-DOS
  - DOS 3.1 or greater is preferred
- Open network, programmer API provided
  - Example for low-level link modules — you can support special hardware
  - Full specs provided on packet level protocols

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6502	2.00	6821	1.00
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6530	3.00	6850	1.75
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6551	2.40	68681	3.00
6800	1.40	68A09EP	1.29
6802	2.50	68A40	4.00
6803	3.00	68A54	3.00
6805	2.95	68B09	4.00
6809EP	2.75	68B10	2.00
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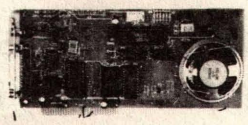

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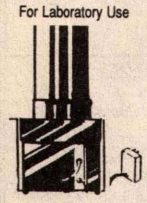

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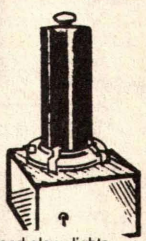

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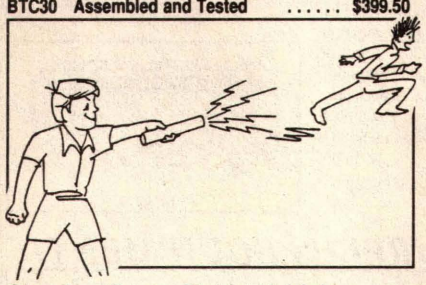

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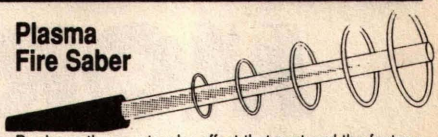

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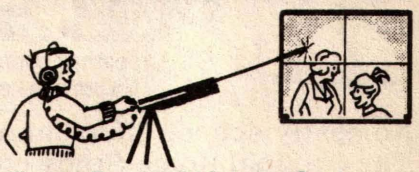

"Laser Bounce" Listener System

allows you to hear sounds from an area via a lite beam reflected from a window or other similar object. System uses our ready-to-use LATR1 Laser Terminator gun site as the transmitter. The receiver section is supplied as an easy-to-build kit, including our cushioned HS10 headsets. **Order # LLIST20 System, includes our LATR1 Ready-to-Use Laser Gun Site, LLR1K Special Receiver Kit, and HS10 Headset, all for only $299.50**

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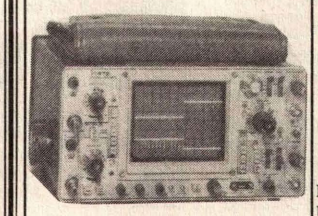
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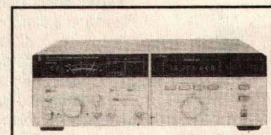
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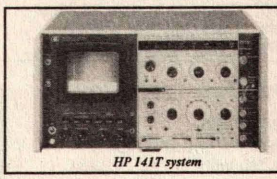
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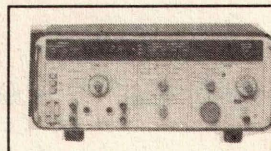
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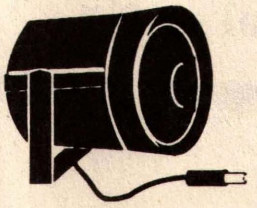
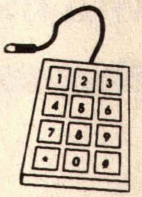
Great for auto alarms, car or boat identifier, verbal entry / exit identifier, etc.

Operates on 12VDC at 1A, standby current 10 micro amps.





CATALOG NO.	ITEM	PRICE
11-1155	IDS-10	$24.99
11-1159	Programming Pad	$9.95

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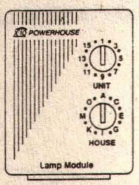
X-10 Lamp Module



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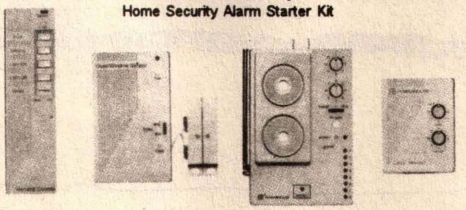

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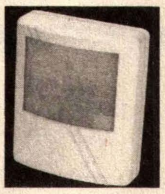

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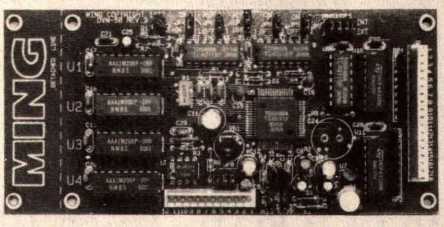

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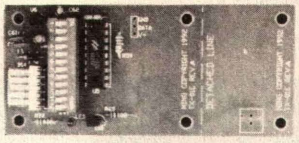

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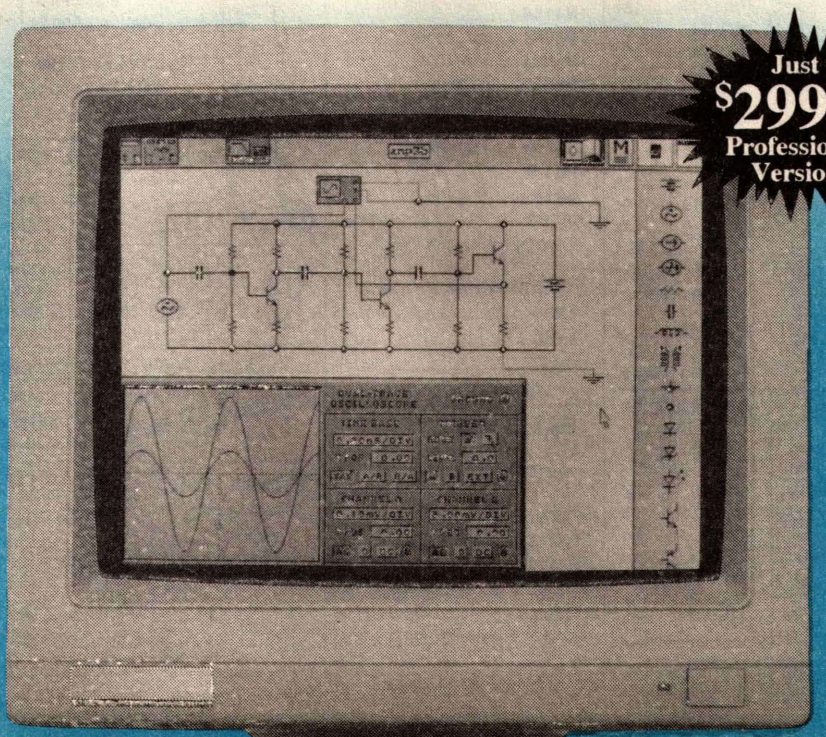

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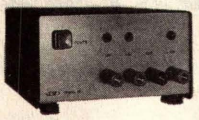

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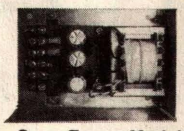

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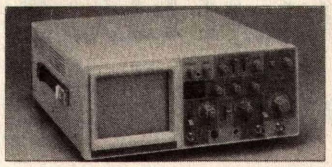

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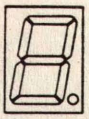

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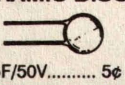

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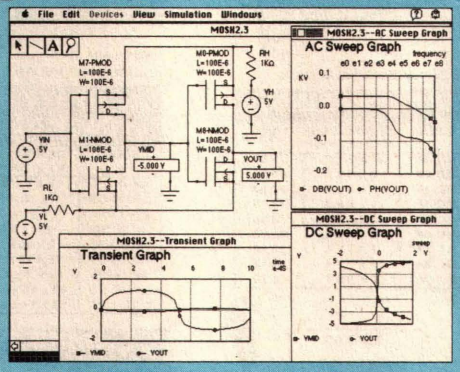

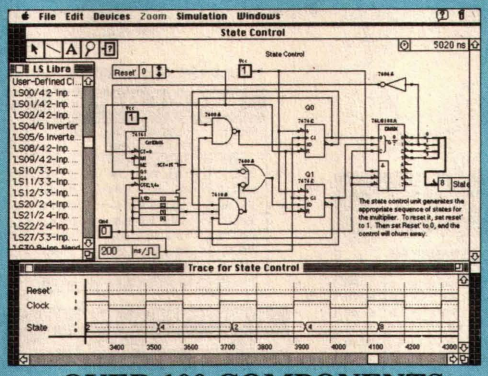

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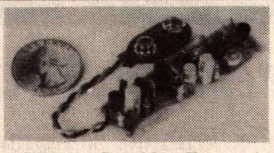

The XTR100 Tracking Transmitter transmits a continuously beeping tone that can be received by any FM receiver. Can be used for games, contests, or as an anti-theft device.
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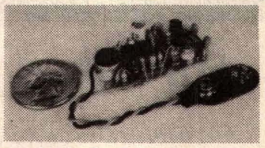

The XFM100 FM transmitter has a range of up to 1 mile. It works with any standard FM receiver. It contains a built in high gain two stage audio amplifier for maximum sensitivity.
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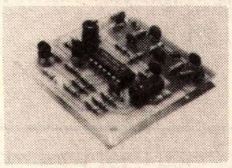

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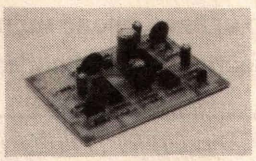

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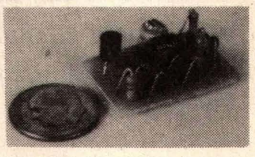

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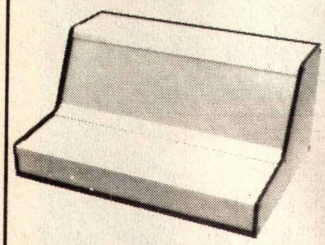

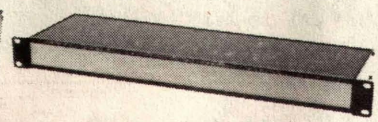

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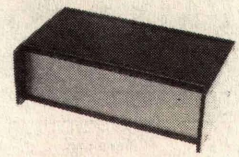

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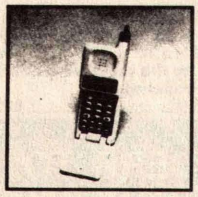
- Cellular phone manufacturer's ESN codes



We now offer cellular phones cloned with your existing number! Buy a handheld, transportable or car mounted phone from us or we can convert your phone! Call for details.

Complete Manual only $79.95

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CIRCLE 296 ON FREE INFORMATION CARD

FROM $19.95 Standard → $199.95 High Performance

GREAT VALUE!

Standard Features - Models 100, 150, 200 & 400

- AC & DC VOLTAGES
- DC CURRENT
- RESISTANCE
- CONTINUITY TESTER - Buzzer
- DIODE TEST
- 3 1/2 Digit LCD
- LOW BATTERY INDICATOR
- ACCURACY +/- 0.5% RDG

Kelvin Meters backed by a 2 Yr Warranty - Parts & Labor

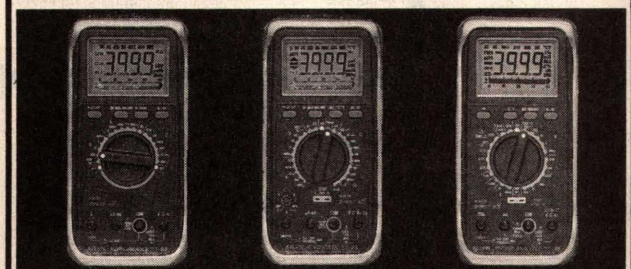
100 Basic | 150 Basic+ | 200 Advanced | PRO 400

BATTERY TEST	TRANSISTOR hFE BATTERY TEST	TRANSISTOR hFE CAPACITANCE AC/DC CURRENT	20MHz FREQ COUNTER AC/DC CURRENT CAPACITANCE LOGIC TEST TRANSISTOR hFE LED TEST - VERIFY GOOD/BAD
KELVIN # 990087	KELVIN # 990090	KELVIN # 990091	KELVIN # 990092
100 Basic	150 Basic+	200 Advanced	PRO 400
$19.95	$29.95	$39.95	$69.95

Protective Cases

For Models 100, 150, 200 ..... $4.95 (990088)

Case For Model Pro 400 ..... $9.95 (990094)



Model 92 PERFORMANCE PLUS | Model 93 DIAGNOSTIC PLUS | Model 95 ENGINE ANALYZER PLUS

Standard Features - Models 92, 93, 94 & 95

- DC/AC VOLTMETERS
- AC/DC CURRENT
- OHM METER
- FREQUENCY COUNTER to 4 MHz
- AUDIBLE CONTINUITY TESTER
- DIODE TESTER
- MAX/MIN AVERAGE MEMORY RECORD
- RELATIVE MODE
- 10A HIGH-ENERGY FUSE PROTECTION
- DATA HOLD
- AUTO SLEEP & AUTO POWER OFF

PERFORMANCE PLUS Model 92 # 990109 **$119.95**

Complete with above ***Standard Features*** plus WATER RESISTANT (92 & 94 Models only), 2 YEAR WARRANTY, YELLOW HOLSTER, PROBES, BATTERY, FUSE, STAND

DIAGNOSTIC PLUS Model 93 # 990110 **$149.95**

Complete with ***Standard & Model 92 Features*** plus LOGIC PROBE, CAPACITANCE TESTER, TRANSISTOR TESTER, TEMPERATURE TESTER & K-TYPE PROBE, HIGH VOLTAGE WARNING BUZZER

ENGINE ANALYZER PLUS Model 95 # 990112 **$199.95**

Complete with ***Standard & Model 92 Features*** plus TEMPERATURE, TACHOMETER & DWELL ANGLE TESTER, DUTY CYCLE, 10 MEGA OHM IMPEDANCE, ANALOG BAR GRAPH, K-TYPE TEMP PROBE, ALLIGATOR CLIP TEST LEADS, INDUCTIVE PICKUP CLIP, 6' TEST LEADS & CARRY CASE

The Ultimate Meter

TRUE RMS - LCR - Hz - dBm

12 INSTRUMENTS IN ONE - **DC VOLTMETER, AC VOLTMETER, OHMMETER, AC CURRENT, DC CURRENT, DIODE TESTER, AUDIBLE CONTINUITY TESTER, dBm, FREQ COUNTER, CAPACITANCE METER, INDUCTANCE METER, LOGIC PROBE**

0.1% ACCURACY on DC Voltages | **Water Resistant**

10 MEGA OHM IMPEDANCE
RELATIVE MODE / DATA HOLD
MAX/MIN AVERAGE MEMORY RECORD
10A HIGH-ENERGY FUSE PROTECTION
AUTO SLEEP & AUTO POWER OFF with Bypass

$199.95 MODEL 94 #990111

COMES COMPLETE WITH YELLOW HOLSTER, PROBES, BATTERY, FUSE, STAND

Freq Counter to 20 MHz

This meter is designed in accordance with relevant safety requirements as specified in IEC-348, UL-1244 and VDE-0411.

Cases for 90 Series Meters

Regular Padded Zippered ... $9.95 (#990116)

Deluxe Padded Zippered ..... $14.95 (#990115)

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TTL LOGIC

PART#	PRICE	PART#	PRICE	PART#	PRICE
7400		*74LS*		74LS173	0.39
7400	0.29	74LS00	0.25	74LS174	0.39
7402	0.29	74LS02	0.25	74LS175	0.39
7404	0.29	74LS04	0.25	74LS191	0.49
7406	0.35	74LS08	0.25	74LS193	0.59
7407	0.35	74LS10	0.25	74LS221	0.59
7408	0.29	74LS14	0.39	74LS240	0.49
7410	0.29	74LS20	0.25	74LS241	0.55
7414	0.35	74LS30	0.25	74LS244	0.69
7432	0.35	74LS32	0.25	74LS245	0.69
7447	0.35	74LS38	0.35	74LS257	0.39
7473	0.49	74LS42	0.39	74LS273	0.69
7474	0.35	74LS51	0.25	74LS293	0.59
7475	0.49	74LS73	0.35	74LS367	0.39
7476	0.65	74LS74	0.29	74LS373	0.69
7483	0.59	74LS75	0.29	74LS374	0.69
7486	0.39	74LS83	0.49	74LS682	1.99
7490	0.69	74LS85	0.49		
7493	0.45	74LS86	0.25	*74S*	
74116	1.49	74LS90	0.39	74S00	0.29
74121	0.49	74LS93	0.39	74S02	0.29
74123	0.49	74LS107	0.39	74S04	0.29
74147	2.15	74LS112	0.35	74S08	0.29
74150	1.29	74LS123	0.39	74S32	0.35
74151	0.39	74LS125	0.39	74S157	0.49
74153	0.59	74LS126	0.39	74S163	0.59
74154	1.35	74LS138	0.39	74S188	1.75
74157	0.45	74LS139	0.39	74S287	1.69
74161	0.45	74LS151	0.39	74S288	1.69
74163	0.49	74LS153	0.39	74S373	0.69
74174	0.59	74LS154	1.15	74S374	0.69
74175	0.59	74LS155	0.49	74S387	1.75
74191	0.85	74LS157	0.39	74S571	2.95
74221	0.45	74LS163	0.49	74S573	2.45

VOLTAGE REGULATORS

PART #	PRICE	PART#	PRICE	PART#	PRICE
UA78S40	1.35	7815K	1.39	7915T	0.45
78L05	0.39	7824T	0.45	7915K	1.49
7805T	0.45	7824K	1.39	7924T	0.45
7805K	1.39	79L05	0.39	7924K	1.49
78M05C	0.49	7905T	0.45	LM317T	0.57
7806T	0.45	7905K	1.49	LM323K	3.25
7808T	0.45	7906T	0.45	LM337K	2.95
78L12	0.39	7908T	0.45	LM337T	0.87
7812T	0.45	79L12	0.39	LM338K	4.95
7812K	1.39	7912T	0.45	LM350K	3.60
78L15	0.39	7912K	1.69	LM350T	2.85
7815T	0.45	79L15	0.39	LM723	0.49

NEC V-20 AND V-30 SERIES

The NEC V-20/30 can improve performance by up to 30%! Pin compatible with the 8088.
- Uses superset of 8088 instructions
- High speed address calculation in hardware
- Low power CMOS design

PART#	PRICE
V20-8	7.95
V20-10	9.95
V30	9.95

LINEAR

PART#	PRICE	PART#	PRICE	PART#	PRICE
MAX232	3.95	LM358	0.49	NE602AN	1.95
LM301	0.39	LM380	0.95	LM709	0.79
LM307	0.49	LM380N-8	1.49	LM741	0.29
LM308	0.69	LM393	0.49	LM747	0.59
LM309K	1.49	LM555	0.29	LM1458	0.39
LM311	0.49	LM556	0.49	LM1488	0.49
LM317K	1.85	NE558	0.75	LM1489	0.49
LM318	0.99	LM565	1.49	LM1881	5.75
LM324	0.35	LM566	1.25	LM3900	0.49
LM339	0.49	LM567	0.69	LM3909	1.49

LIGHT EMITTING DIODES

PART #	DESCRIPTION	PRICE
MAN72	7-SEGMENT .3" COMMON ANODE LED	0.99
MAN74	7-SEGMENT .3" COMMON CATHODE LED	0.99
LED-JR	JUMBO T1-3/4 RED LED	0.10
LED-JG	JUMBO T1-3/4 GREEN LED	0.14
LED-JY	JUMBO T1-3/4 YELLOW LED	0.14

EPROMS

PART#	SIZE	SPEED	Vpp	PINS	PRICE
2732A-250	4096x8	250ns	21V	24	3.95
2764A-450	8192x8	450ns	12.5V	28	3.95
2764A-250	8192x8	250ns	12.5V	28	3.95
2764A-200	8192x8	200ns	12.5V	28	4.49
27128A-200	16384x8	200ns	12.5V	28	4.95
27256-250	32768x8	250ns	12.5V	28	4.95
27C256-250	32768x8	250ns	12.5V	28	5.95
27C512-150	65536x8	150ns	12.5V	28	6.75
27C101-200	131072x8	200ns	12.5V	32	7.95
27C101-150	131072x8	150ns	12.5V	32	8.25

STATIC RAM

PART#	SIZE	SPEED	PINS	CMOS	LP	PRICE
HM6116-2	2048x8	120ns	24	Y	N	2.95
HM6116LP-2	2048x8	120ns	24	Y	Y	3.95
HM6264LP-10	8192x8	100ns	28	Y	Y	5.95
HM62256LP-12	32768x8	120ns	28	Y	Y	5.95
HM62256LP-10	32768x8	100ns	28	Y	Y	6.95
HM62832-20	32768x8	20ns	28/.3"	Y	Y	13.95
HM62832-15	32768x8	15ns	28/.3"	Y	Y	16.95
HM628128LP-10	131072x8	100ns	32	Y	Y	22.95
HM628128LP-85	131072x8	85ns	32	Y	Y	24.95

PALS

PART#	SPEED	PINS	IN	OUT	I/O'S	FUNCTIONS	PRICE
16L8	35ns	20	10	2	6	AND-OR INV	2.25
16R4	35ns	20	8	4	4	AND-OR INV	2.25
16R6	35ns	20	8	6	2	AND-OR INV	2.25
20L8	40ns	24	14	2	6	AND-OR INV	2.25
20R4A	25ns	24	12	4	2	AND-OR INV	2.45
20R6	40ns	24	12	6	2	AND-OR INV	2.25
20R8	40ns	24	12	8	-	AND-OR INV	2.25
20X8	50ns	24	10	8	2	AND-OR-XOR INV	2.95
20L10	40ns	24	10	12	2	AND-OR-INV	2.95

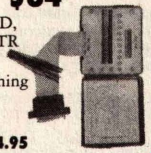
GALS

PART#	SPEED	PINS	REPLACES	IN	OUT	PRICE
16V8	35ns	20	10L8 TO 16RP8	8	8	1.95
16V8-15	15ns	20	10L8 TO 16RP8	8	8	2.25
20V8	35ns	24/.3"	14L8 TO 16RP8	20	8	2.95
20V8-15	15ns	24/.3"	14L8 TO 16RP8	20	8	3.45
22V10	35ns	24/.3"	PGM OUTPUTS	22	10	6.95
22V10-15	15ns	24/.3"	PGM OUTPUTS	22	10	13.95

8000 SERIES MICROPROCESSORS

PART #	PRICE	PART #	PRICE	PART #	PRICE
8031	3.75	8742	14.95	80486-33	599.00
8032A	8.95	8748H	8.95	8087	89.95
80C32	10.95	8749H	9.95	8087-2	129.95
8155	2.85	8751H	29.95	8087-1	169.95
8251A	2.89	87C51	39.95	80287-XL	89.95
8253-5	2.75	8755A	14.95	80387-SXP	79.95
8255-5	2.69	8088-1	7.95	80387-DXP	89.95
82C55-5	3.95	R80286-16	34.95	80487-SX	389.95
8257-5	3.49	80386-33	299.95	ODP486-SX20	449.95

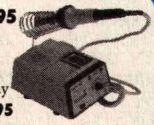
RS-232 BREAKOUT BOX $34.95



- Ten bi-polar LEDs monitor TF, RD, RTS, CTS, DSR, CD, TC, RC, DTR and TC signals (2 spare)
- 24 switches for breakout and patching
- Includes jumper wires
- Requires no battery

BRBOX-BO $34.95

SOLDER STATION $79.95



- 60 watts thermostatically controlled heat from 200°-900° F
- Solder gun, gun-rest & cooling tray

168-3C $79.95

SOLDER/DESOLDER STATION

- Oil-free vacuum pump
- Adjustable temperature (200°-900° F) and vacuum (060cm/Hg)

XY999SD-A $399.95

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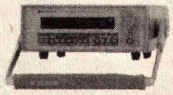
ALL JDR INSTRUMENTS CARRY A 2 YEAR WARRANTY

35MHZ OSCILLOSCOPE

- Exceptionally bright CRT
- TV sync filter
- Fast 10ns rise time
- Delayed & single sweep modes

MODEL-3500 ..... $499.95
MODEL-2000 20MHz version, no delay $389.95
TAB38911 Troubleshooting w/your Oscilloscope $18.95

100MHZ MULTIFUNCTION COUNTER



- Range: 10Hz to 10MHz direct, 10MHz to 100MHz prescaled by 10
- Period measurements: 10Hz to 2.5MHz,±1 count accuracy
- Time base:10MHz
- 8 digit LED display with decimal point

DFC-100 ..... $179.95
DFC-1000 1 GHz version $199.95
DFG-600 Sweep function generator $189.95
DOS-600 Audio oscillator/counter $189.95

3.5 DIGIT DMM $79.95

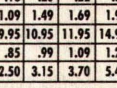
- Basic DC accuracy ±0.25%
- DC voltage: ± .1mV-1000V; AC voltage: ± .1mV-750V; AC/DC current: 1µA - 20A Resistance: ± .1Ω - 20MΩ
- Input impedance: 10MΩ • 28 ranges

DMM-300 ..... $79.95
DMM-150 3.5 digit DMM with 14 ranges $29.95
LP-100 Logic probe $17.95
LP-200 Pulser probe $19.95

D-SUBMINIATURE CONNECTORS

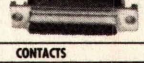
TYPE		ORDER BY	CONTACTS 09	15	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	1.39	2.29
R/A PC SOLDER	MALE	DBxxPR	.49	.69	.79	2.27	—
	FEMALE	DBxxSR	.55	.75	.85	2.49	—
W/W TYPE	MALE	DBxxPWW	1.69	2.56	3.89	5.60	—
	FEMALE	DBxxSWW	2.76	4.27	6.84	9.95	—
IDS TYPE	MALE	IDBxxP	1.39	1.99	2.25	4.25	—
	FEMALE	IDBxxS	1.45	2.05	2.35	4.49	—
HOODS	METAL	MHOODxx	1.05	1.15	1.25	—	—
	PLASTIC	HOODxx	.39	.39	.39	.69	.75

IC SOCKETS DIP CONNECTORS



TYPE	ORDER BY	CONTACTS 08	14	16	20	24	28	40
SOLDERTAIL	xx PIN ST	.11	.11	.12	.18	.20	.22	.30
WIREWRAP	xx PIN WW	.59	.69	.69	1.09	1.49	1.69	1.99
ZIF	ZIF-xx	—	6.95	6.95	9.95	10.95	11.95	14.95
TOOLED	AUGATxx	.55	.59	.69	.85	.99	1.09	1.29
TOOLED WW	AUGATxxWW	1.30	1.80	2.10	2.50	3.15	3.70	5.40

IDC CONNECTORS AND CABLE



TYPE	ORDER BY	CONTACTS 20	26	34	40	50
SOLDER HEADER	IDHxxS	1.29	1.68	2.20	2.58	3.24
R/A HEADER	IDHxxSR	1.35	1.76	2.31	2.72	3.39
W/W HEADER	IDHxxW	2.98	3.84	4.50	5.28	6.63
R/A W/W HEADER	IDHxxWR	3.28	4.22	4.45	4.80	7.30
HEADER SOCKET	IDSxx	.65	.75	.75	1.19	1.19
RIBBON HEADER	IDMxx	5.50	6.25	7.00	7.50	8.50
IDC EDGE CARD	IDExx	.55	.75	.89	1.29	1.69
RIBBON CABLE	RCxx	.30	.39	.51	.60	.75

To order: insert the number of contacts in the position marked "xx" of the "order by" part number listed. Ex: a 15-pin right angle male PC solder part would be DB15PR.

VISA MasterCard

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16-BIT VGA CARD $49.95

- 8/16-bit 8088 or 286/386/486 compatible
- 640 x 480 in 16 colors 320 x 200 in 256 colors
- 256Kb video RAM

MCT-VGA-1000 .... **$49.95**
MCT-VGA-3000 1024x768, 512 Kb VGA card **$89.95**
MCT-IDEFH 16-bit IDE hard/floppy controller **$29.95**
MCT-IDEIO 16-bit IDE floppy/hard multi I/O **$69.95**
MCT-IDE-8 8-bit 8088 IDE controller **$79.95**
MCT-AIO Serial/parallel/game port card **$49.95**
MCT-AIO+ Two NS16550 serial/par/game port .. **$89.95**
MCT-FDC-HD 1.44Mb floppy controller **$49.95**
GATEKEEPER PC security card **$49.95**
PCODE Diagnostic display card **$49.95**

CONNER 84Mb DRIVE PACKAGE $259

- CP-30084 84Mb, 19ms IDE hard drive, 16-bit floppy/ hard disk controller, cables and instructions

HDKIT80 ..... **$259.00**

IDE HARD DRIVES

PART #	BRAND	CAP.	SPEED	TYPE	PRICE
CP-3000	Conner	42Mb	28ms	3.5" IDE	$189
ST-351A	Seagate	42Mb	28ms	3.5" IDE	$199
CP-30084	Conner	84Mb	19ms	3.5" IDE	$239
ST-3096A	Seagate	88Mb	16ms	3.5" IDE	$259
CP-30104	Conner	120Mb	19ms	3.5" IDE	$319
ST-3144A	Seagate	131Mb	16ms	3.5" IDE	$319
CP-3204F	Conner	212Mb	16ms	5.25" IDE	$479

FLOPPY DRIVES

FDD-1.44A 1.44Mb, 3.5", Beige .. **$79.95**
FDD-1.2 1.2Mb, 5.25", Beige **$89.95**
FDD-360 360Kb, 5.25", Black **$89.95**
FD-505 5.25" & 3.5" combo **$149.95**

UNIVERSAL PROGRAMMER

- Programs EPROMs, EEPROMs, microprocessors, PROMs, PAL/GALs and other PLDs; tests logic & memory devices
- Optional adaptors available for PLCC, PGA, QFP and multiple DIP devices
- Includes host adaptor card and cable

MOD-EMUP **$699.00**

EPROM PROGRAMMER

- Programs devices up to 512K bits, and 27C100, 27C101, 27C301, 27C1000, 27C1001, 27C2001, 27C4001 and more
- Ded. 8-bit 8088 & 286/386/486 PC compatible card
- ZIF socket accepts 0.6"W DIP IC's to 32 pins

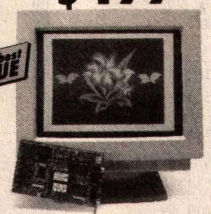
MOD-MEP-1A **$199.95**
MOD-MEP-4A As above with 4 ZIF sockets **$269.95**

EPROM ERASER $39.95

- Quickly and simultaneously erases up to 4 standard EPROMs
- Includes wall plug power supply

DATARASE II **$39.95**

1024 X 768 NON-INTERLACED VGA PACKAGE $499.95



- 0.28mm dot pitch non-interlaced monitor and high-resolution VGA card
- Resolution up to 1024 x 768 in 256 colors
- 1Mb video RAM

VGA-PKG-1024N .. **$499.95**
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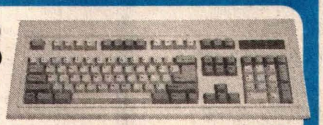

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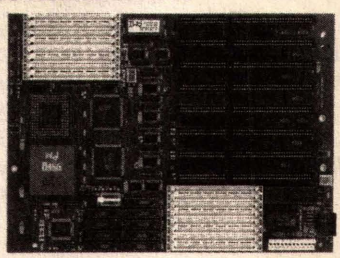

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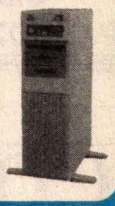

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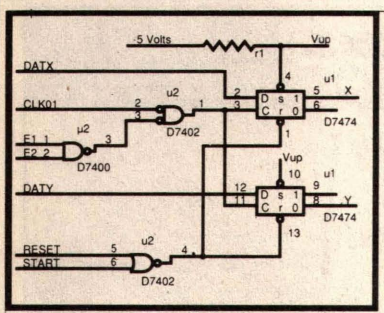

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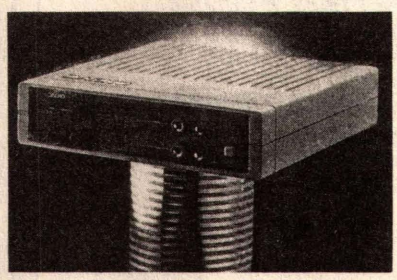

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74148	1.29
74150	1.39
74151	.69
74153	.69
74154	1.59
74155	.89
74156	.87
74157	.73
74159	2.09
74160	.89
74161	.79
74162	.89
74163	.79
74164	.89
74165	.89
74166	1.09
74167	4.00
74170	1.89
74172	5.95
74173	.89
74174	.99
74175	.99
74176	.99
74177	.89
74178	3.49
74179	2.30
74180	.89
74181	2.09
74182	1.00
74184	3.49
74185	3.49
74190	1.29
74191	1.29
74192	.89
74193	.89
74194	1.24
74195	1.24
74196	.99
74197	.85
74198	2.19
74199	1.39
74221	1.39
74246	4.95
74247	3.95
74248	4.95
74249	4.95
74251	1.00
74259	3.49
74265	1.39
74273	2.95
74276	1.99
74278	2.95
74279	.89
74283	2.09
74284	4.00
74285	4.00
74290	.99
74293	1.59
74298	.99
74351	2.59
74365	.87
74366	.87
74367	.87
74368	.87
74376	2.70
74390	2.19
74393	1.39
74425	2.95
74426	.99
74490	4.95

74LSxx

74LS00	.30
74LS01	.30
74LS02	.30
74LS03	.30
74LS04	.30
74LS05	.30
74LS08	.30
74LS09	.30
74LS10	.30
74LS11	.34
74LS12	.34
74LS13	.35
74LS14	.49
74LS15	.35
74LS19	.47
74LS20	.30
74LS21	.34
74LS22	.34
74LS26	.34
74LS27	.34
74LS28	.40
74LS30	.30
74LS32	.30
74LS33	.40
74LS37	.40
74LS38	.40
74LS40	.34
74LS42	.45
74LS47	.89
74LS48	.89
74LS49	2.95
74LS51	.30
74LS54	.34
74LS55	.34
74LS63	.89
74LS73	.40
74LS74	.34
74LS75	.38
74LS76	.45
74LS78	.59
74LS83	.59
74LS85	.59
74LS86	.59
74LS90	.52
74LS91	.69
74LS92	.65
74LS93	.49
74LS95	.59
74LS96	.59
74LS107	.45
74LS109	.48
74LS112	.40
74LS113	.45
74LS114	.45
74LS122	.60
74LS123	.59
74LS124	2.69
74LS125	.52
74LS126	.52
74LS132	.52
74LS133	.59
74LS136	.52
74LS137	.59
74LS138	.52
74LS139	.52
74LS145	.69
74LS147	1.59
74LS148	.69
74LS151	.52
74LS153	.52
74LS154	1.69
74LS155	.59
74LS156	.65
74LS157	.47
74LS158	.38
74LS160	.38
74LS161	.52
74LS162	.65
74LS163	.59
74LS164	.59
74LS165	.75
74LS166	.79
74LS168	.99
74LS169	.99
74LS170	.69
74LS173	.55
74LS174	.52
74LS175	.52
74LS181	1.99
74LS189	4.95
74LS190	.65
74LS191	.65
74LS192	.69
74LS193	.69
74LS194	.69
74LS195	.69
74LS196	.59
74LS197	.59
74LS221	.69
74LS240	.79
74LS241	.79
74LS242	.69
74LS243	.69
74LS244	.79
74LS245	.79
74LS247	.89
74LS248	.92
74LS249	2.09
74LS251	.65
74LS253	.65
74LS256	1.00
74LS257	.52
74LS258	.65
74LS259	.79
74LS260	.65
74LS261	4.95
74LS266	.52
74LS273	.89
74LS275	2.19
74LS279	.52
74LS280	1.09
74LS283	.78
74LS290	.79
74LS293	.79
74LS295	.79
74LS298	.85
74LS299	1.79
74LS322	1.69
74LS323	1.69
74LS324	2.30
74LS327	1.09
74LS348	.99
74LS352	1.09
74LS353	1.09
74LS363	2.29
74LS364	1.09
74LS365	.52
74LS366	.52
74LS367	.52
74LS368	.52
74LS373	.89
74LS374	.89
74LS375	1.19
74LS377	.99
74LS378	1.09
74LS379	1.19
74LS385	2.19
74LS386	.60
74LS390	.99
74LS393	.89
74LS395	.99
74LS396	.99
74LS399	.99
74LS424	4.00
74LS447	1.19
74LS490	2.19
74LS540	1.09
74LS541	1.09
74LS623	1.49
74LS624	2.19
74LS629	2.69
74LS640	1.28
74LS641	1.50
74LS643	1.28
74LS645	1.19
74LS646	1.69
74LS668	1.39
74LS669	1.09
74LS670	1.09
74LS674	14.95
74LS682	2.19
74LS683	2.19
74LS684	2.69
74LS685	8.00
74LS688	2.19
74LS689	3.50
74LS783	25.00
25LS22	3.00
25LS23	.96
26LS33	2.00
25LS2518	2.19
25LS2521	2.19
25LS2538	3.45
25LS2569	2.19
81LS95	1.19
81LS96	1.09
81LS97	1.69
81LS98	1.69

74Sxx

74S00	.39
74S02	.39
74S04	.39
74S05	.35
74S10	.39
74S11	.39
74S20	.35
74S30	.39
74S32	.45
74S37	.49
74S38	.49
74S40	.49
74S51	.45
74S64	.45
74S65	.50
74S74	.89
74S85	.89
74S86	.50
74S112	.50
74S113	.59
74S114	.59
74S124	2.99
74S132	.69
74S133	.50
74S140	.60
74S151	.69
74S153	.69
74S157	.99
74S158	.89
74S161	1.35
74S163	.69
74S174	.69
74S175	.59
74S189	1.99
74S195	1.19
74S240	1.19
74S241	1.19
74S253	.89
74S257	.69
74S258	.69
74S260	.69
74S280	1.19
74S283	1.19
74S287	1.89
74S373	1.19
74S412	3.00

74HCxx

74HC00	.32
74HC02	.32
74HC04	.34
74HC08	.34
74HC10	.34
74HC11	.34
74HC14	.47
74HC20	.34
74HC27	.34
74HC30	.34
74HC32	.47
74HC51	.34
74HC74	.39
74HC75	.39
74HC85	.99
74HC86	.45
74HC93	1.69
74HC107	.49
74HC109	.49
74HC112	.49
74HC125	.59
74HC132	.59
74HC133	.59
74HC138	.59
74HC139	.60
74HC148	.89
74HC151	.59
74HC153	.59
74HC154	1.69
74HC157	.59
74HC158	.49
74HC161	.59
74HC163	.59
74HC164	.59
74HC165	.79
74HC166	.79
74HC174	.69
74HC175	.69
74HC193	.79
74HC194	.79
74HC195	.79
74HC237	.89
74HC238	.79
74HC240	.89
74HC241	.89
74HC242	.89
74HC243	.89
74HC244	.89
74HC245	.89
74HC251	.65
74HC257	.59
74HC258	.69
74HC259	.69
74HC273	.92
74HC280	.92
74HC299	1.72
74HC367	.69
74HC368	.69
74HC373	.92
74HC374	.92
74HC390	.89
74HC393	.79
74HC573	1.79
74HC595	1.79
74HC652	1.79
74HC688	2.19
74HC4017	1.19
74HC4020	1.09
74HC4024	1.09
74HC4040	1.09
74HC4049	.79
74HC4050	.78
74HC4060	.89
74HC4075	.79
74HC4511	2.19
74HC4538	1.09

74HCTxx

74HCT00	.34
74HCT02	.34
74HCT04	.36
74HCT08	.34
74HCT10	.34
74HCT11	.40
74HCT14	.47
74HCT20	.34
74HCT27	.45
74HCT30	.34
74HCT32	.37
74HCT74	.45
74HCT75	.45
74HCT85	.34
74HCT86	.34
74HCT123	.99
74HCT125	.99
74HCT138	.59
74HCT139	.59
74HCT151	.59
74HCT154	2.60
74HCT157	.59
74HCT158	.69
74HCT161	.89
74HCT164	.89
74HCT165	1.89
74HCT166	1.09
74HCT174	.59
74HCT175	.59
74HCT193	.79
74HCT194	.79
74HCT195	.79
74HCT237	.89
74HCT238	.79
74HCT240	.89
74HCT241	.89
74HCT242	.99
74HCT243	.99
74HCT244	.99
74HCT245	.99
74HCT251	.92
74HCT257	.79
74HCT259	.79
74HCT273	.99
74HCT299	1.29
74HCT367	.69
74HCT368	.85
74HCT373	.89
74HCT374	.99
74HCT377	.99
74HCT393	.99
74HCT670	1.09
'HCT4017	1.29
'HCT4020	1.29
'HCT4040	1.09
'HCT4060	1.29
'HCT4538	1.29

4000

4000	.34
4001	.34
4002	.34
4006	.59
4007	.34
4008	.79
4009	.79
4010	.49
4011	.34
4012	.34
4013	.47
4014	.69
4015	.49
4016	.49
4017	.59
4018	.69
4019	.47
4020	.69
4021	.69
4022	.69
4023	.34
4024	.65
4025	.34
4026	.69
4027	.59
4028	.79
4029	.79
4030	.49
4034	1.39
4035	1.09
4040	.69
4041	.79
4042	.69
4043	.89
4044	.79
4045	1.39
4046	.79
4047	.79
4048	.79
4049	.34
4050	.34
4051	.79
4052	.79
4053	.79
4056	1.19
4060	.69
4066	.38
4068	.49
4069	.34
4070	.38
4071	.34
4072	.34
4073	.34
4075	.39
4076	.69
4077	.38
4078	.45
4081	.34
4082	.34
4085	.79
4086	.79
4093	.49
4094	1.39
4098	1.19
4099	1.39
40106	.70
40107	.70
40174	.89
4501	.65
4502	.99
4503	.59
4507	1.19
4508	1.19
4510	.79
4511	.79
4512	.79
4514	1.19
4515	1.69
4516	.79
4518	.79
4519	.79
4520	.79
4521	1.19
4522	.99
4526	.89
4527	.99
4528	.89
4529	1.19
4530	.89
4531	.99
4532	1.19
4538	.99
4539	1.19
4541	1.19
4543	1.19
4552	1.35
4553	2.95
4555	.79
4556	.79
4558	1.69
4560	3.50
4561	2.00
4566	2.00
4569	2.99
4572	.90
4581	1.69
4582	1.69
4584	.69
4585	.79
4702	9.95
4724	1.19
14174	.60
14175	.60
14409	12.95
14410	6.95
14411	9.95
14412	6.95
14419	4.95
14433	6.95
14451	1.50
14490	4.95
14497	6.95

LINEAR

TL061	1.19
TL062	1.19
TL064	1.99
TL066	1.19
TL071	.79
TL072	.79
TL074	1.39
TL081	.78
TL082	.79
TL083	1.19
TL084	1.39
LM150K	4.95
LM207	.50
LM208	.50
XR215	1.50
MAX232	5.95
LM301	.59
LM307	.59
LM308	.87
LM309H	2.95
LM309K	1.50
LM310	1.99
LM311	.69
LM312H	5.50
LM316	4.00
LM317K	1.99
LM317T	.79
LM318	1.39
LM319	1.39
LM322	2.19
LM323K	3.99
LM324	.45
LM329	.89
LM331	6.95
LM334	1.69
LM335	1.99
LM336	1.39
LM337K	4.25
LM337T	1.19
LM338K	6.95
LM339	.59
LF347	.89
LM350K	4.95
LM350T	3.95
LF351	.69
LF353	.69
LF355	1.69
LF356	.99
LF357	1.19
LM358	.59
LM359	2.69
LM376	1.39
LM380	.79
LM381	3.95
LM382	2.69
LM383	2.95
LM384	2.60
LM386	.99
LM387	2.69
LM389	2.19
LM390	2.19
LM392	.99
LM393	.59
LF411	.99
LF412	2.19
TL489	1.59
TL494	3.25
TL496	1.69
TL497	2.69
NE531T	1.99
LM555	.38
LM556	.65
LM558	1.19
NE564	2.19
LM565	1.19
LM566	1.69
LM567	.79
NE570	3.25
NE571	2.69
NE590	2.69
NE592	.79
LM709	.69
LM710	.79
LM711	.89
LM723	.65
LM723H	1.29
LM733	.79
LM741	.38
LM741HC	1.49
LM747	.79
LM748	.79
LM1014	2.69
LM1303	1.69
LM1310	1.69
MC1330	1.69
MC1349	2.09
MC1350	1.29
MC1358	1.69
MC1372	2.69
MC1374	2.00
LM1414	1.69
MC1456	1.50
MC1458	.47
LM1488	.65
LM1489	.65
MC1496	.99
MC1558	3.50
MC1648	.90
MC1723CL	1.00
MC1733CL	1.00
LM1800	2.69
LM1812	7.95
LM1830	4.95
LM1871	6.95
LM1872	7.95
LM1877	3.95
LM1889	3.95
LM1896	1.99
ULN2001	.79
ULN2003	.79
ULN2004	.79
XR2206	5.25
XR2207	4.25
XR2208	3.25
XR2211	3.30
XR2240	2.50
XR2242	1.50
XR2567	2.50
LM2900	2.19
LM2901	.89
LM2907	2.69
LM2917	2.19
CA3018	1.50
CA3039	2.59
CA3046	.99
CA3059	3.20
CA3060	3.95
CA3065	1.70
CA3080	1.18
CA3081	.79
CA3082	1.19
CA3083	1.19
CA3086	.99
CA3089	1.69
CA3096	1.79
CA3130	.99
CA3140	.89
CA3146	1.39
CA3160	1.19
CA3162	4.00
CA3183	.99
CA3401	1.50
MC3302	.75
MC3340	1.69
MC3346	1.99
MC3360	1.50
MC3373	1.70
MC3401	.90
MC3403	.70
MC3470	2.19
MC3480	9.95
MC3486	3.00
MC3487	2.19
LM3900	.69
LM3905	2.69
LM3909	1.69
LM3911	2.19
LM3914	2.69
LM3915	2.69
LM3916	2.69
MC4001	4.00
MC4016	2.75
MC4024	4.00
MC4044	5.95
MC4136	1.39
MC4741	.50
ICL8038	2.19
ICL7660	2.25
7106	7.95
7107	8.95
7207	7.95
7208	20.00
75107	1.19
75108	1.19
75110	1.69
75138	1.69
75150	1.69
75154	1.69
75160	4.25
75188	1.19
75189	1.19
75365	1.69
75450	.59
75451	.59
75452	.59
75453	.59
75454	.59
75477	1.39
75491	.89
75492	1.19
75493	.99
75494	1.39

TRANSISTORS

MCR102	1.00
MPSU02	.25
VN10	1.95
D41K2	1.15
D42C8	1.00
BF167	.50
3N200	5.00
C203YY	1.00
J310	.75
MJE340	1.00
IRF353	8.25
IRF541	3.00
2N697	.70
MJ900	1.50
MPS918	.25
MJ1000	1.50
2N1678	.50
NE02136	1.00
2N2218	.50
2N2219	.50
PN2222	.20
2N2222	.30
MPS2369	.29
T2850D	1.00
2N2905	.50
2N2907	.25
PN2907	.20
MJE2955	1.50
2N3055	.85
2N3393	.35
MPN3401	.25
2N3417	.40
2N3567	.55
2N3568	.25
MPS3638	.25
PN3643	.25
MPS3702	.25
2N3703	.25
2N3704	.25
2N3730	.50
2N3772	1.99
2N3866	1.20
2N3903	.30
2N3904	.20
2N3905	.20
2N3906	.20
2N3958	1.50
2N4123	.30
2N4124	.30
2N4126	.30
2N4220	1.00
2N4236	1.59
2N4240	1.00
2N4385	.50
2N4401	.30
2N4402	.30
2N4403	.30
2N4424	.25
2N4857	1.10
2N4919	.30
2N4992	.25
2N5086	.30
2N5109	1.50
2N5222	.35
2N5306	.50
2N5308	.50
2N5401	.35
2N5484	.35
2N5550	.35
2N5819	.50
2N5840	6.00
2N5875	2.00
2N5878	2.49
2N6037	.45
2N6043	1.85
2N6045	1.85
2N6107	1.10
2N6124	1.00
2N6251	4.00
2N6292	1.10
MPS6513	.20
2N6719	.50
MJ11032	1.95
MJ14000	2.25
40348	.50
40439	.50
MPSA-05	.30
MPSA-06	.30
MPSA-13	.50
MPSA-20	.20
MPSA-42	.35
MPSA-43	.38
MPSA-55	.30
MPSA-56	.35
MPSA-65	.15
MPSA-70	.15
MPSA-92	.40
MPSA-93	.40
TIP29	.70
TIP30	.59
TIP31	.59
TIP32	.59
TIP48	.89
TIP105	.65
TIP110	.95
TIP112	1.20
TIP122	.89
TIP125	.70
TIP127	.70
TIP141	1.69
TIP146	1.69
TIP2955	1.99

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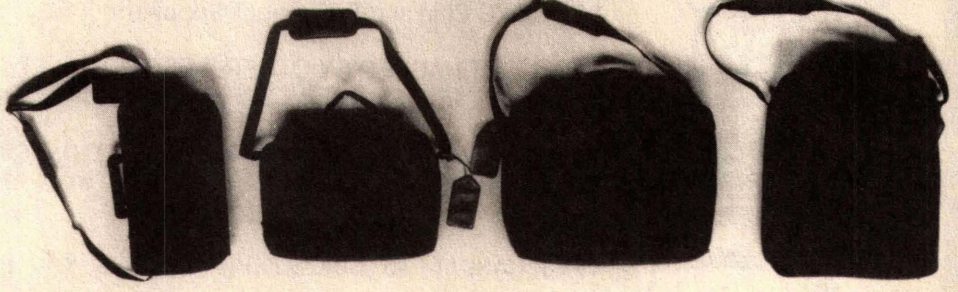

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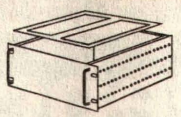

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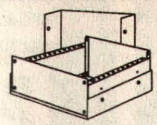

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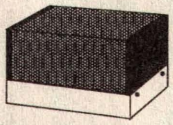

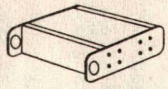

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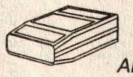

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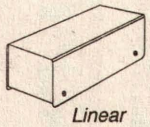

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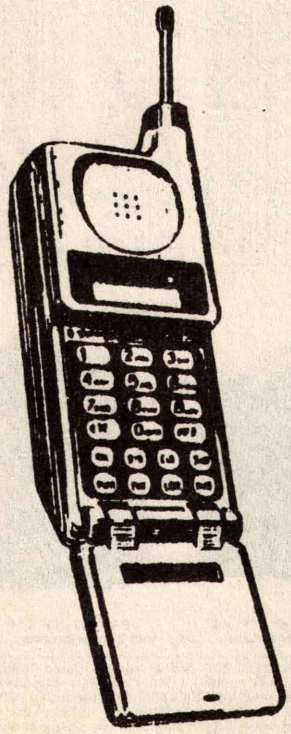

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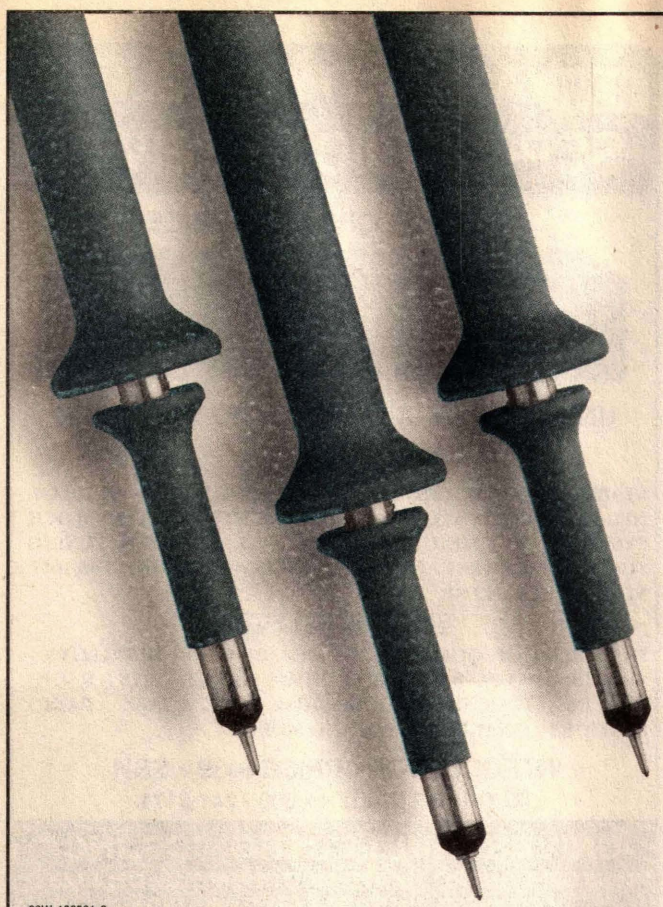

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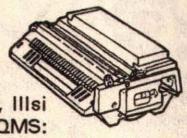

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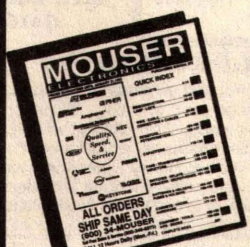

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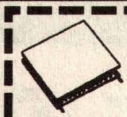

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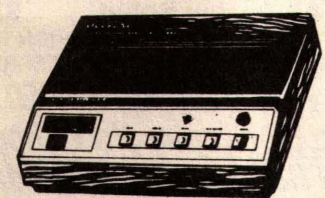

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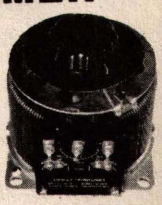

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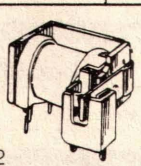

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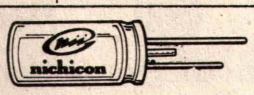

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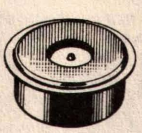

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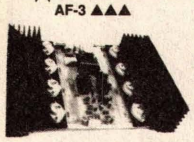

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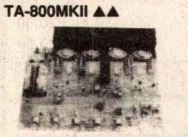
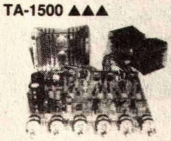
TA-800MKII ▲▲



Power Output: 120 watts each channel into 4 ohm load. 72 watts each channel into 8 ohm load. Frequency response: 10 to 20 Khz. Total harmonic distortion: Less than .01%. Tone control: Bass: ± 12 dB. Mid: ± 8 dB. High: ± 8 dB. Sensitivity: Phono input, 3 mv into 47 K. Line, .3 v into 47 K. Signal to noise ratio: 86 dB. Power requirement: DC, ± 40 VDC at 3.2 A, 8 ohm load. DC, ± 40 VDC at 5.4 A, 4 ohm load. AC, 28 VAC-O-28VAC at 6.5 A with 8 ohm load. AC, 28 VAC-O-28VAC at 10.8 A with 4 ohm load.

Kit: $63.92

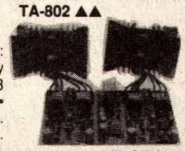
100W + 100W NEW CLASS A DC STEREO PRE AND MAIN AMP
TA-1500 ▲▲▲



Power output: 80 watts per channel into 8 ohms 100 watts per channel into 4 ohms • Total harmonic distortion. Less than 0.03% Frequency response. Aux input. 5 to 50,000 Hz + 0.2dB. -2 dB • Frequency response. Power amplifier section. DC to 200 KHz • Sensitivity Phono: 2.5 mV @ 47 K Aux: 150 mV @ 47K Mic 6 mV @ 10 K Output: Tape 150 mV @ 47 KPreamp 1V @ 600 ohms • Power transformer: 26V to 32 V AC x 2 @ 6 A (Mark V Model 001) • P.C. Board Dimensions: 10.5" x 6.13" x 2.25" • Heat sink 5.13"x 2.63" x 3" (Each) Use rack mount cabinet LG 1924 or LG 1925

Kit: $73.70
Assembled & Tested: $95.81

80W + 80W PURE DC STEREO MAIN POWER AMPLIFIER
TA-802 ▲▲



Power output::80 watts per channel into 8 ohms Total harmonic distortion: Less than 0.05% at rated power. Intermodulation distortion: Less than 0.05% at rated power Frequency response: DC to 200 KHz. -0 db, -3dB. @ 1 watt Power requirements: 30 VAC x 2@ 6 amp. May use Mark V model 001 transformer P.C. Board: 8-1/2"x5"x1-1/8" Heat sink: 5-1/8" x 2-5/8" x 3' (Each)

Kit: $45.94
Assembled & Tested: $59.72

120W + 120W AC/DC STEREO HI-FI & PRE-AMP.
SM-720 ▲▲★

Power Output: 120 W Peak music power output per channel. Input Sensitivity: Tape 300 mv, Aux 300 mv, Phono 3 mv, Mic 3 mv. Tone control range: Treble ± 8 dB, Bass ± 8 dB. Frequency Response: 20 Hz to 20 Khz. Power Requirements: 110 VAC, 220 VAC, 50/60 Hz 12 to 16 VDC. Dimesions: 272 x 208 x 80 mm 10 5/8 x 8 1/8 x 3 1/8 inch.

Complete Kit: $75.00
Assembled & Tested: $89.00

Nuevo

VIDEO/AUDIO SURROUND SOUND PROCESSOR
SM-333 ▲▲★

Frequency response: 20 Hz to 20KHz • Total harmonic distortion. Front channel: 0.05%. Rear channel: Less than 0.25% • Input signal voltage: 0.1 to 3.5V • Output: Front channel: 0.1 to 3.5V • Output: Front channel: 0.1 to 3.5V • Rear channel: 6.6V • Delay time: 5 to 50 milliseconds • Input impedance: 47 K • Power requirements: 100-120 VAC. 60Hz • Dimensions: 14.2" wide. 4.82" deep. 2.1" high

Complete Kit: $73.00
Assembled & Tested: $85.00

60W + 60W STEREO POWER AMPLIFIER (WITH MIC. INPUT)
SM-302 ▲▲★

Frequency response: 20Hz to 20 KHz • Total harmonic distortion: < 0.1% • Power output: 60W per channel into 4 ohm load • 33W per channel into 8 ohm load • Input sensitivity: Mic 10mv • Hi 380mv • Lo 640mv • Signal to noise ratio: Better than 70 db • Power consumption: 100W. Dimension 360 mm x 75 mm x 200 mm

Complete Kit: $73.00
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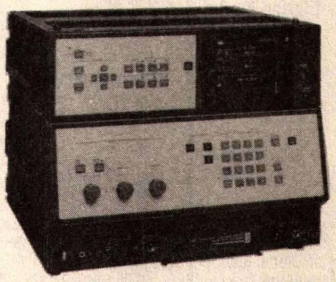

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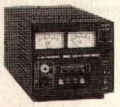

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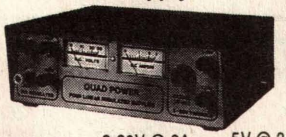

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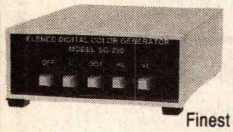

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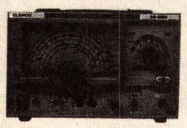

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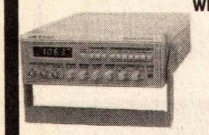

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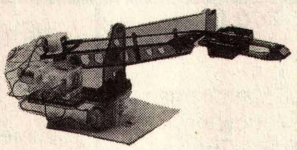

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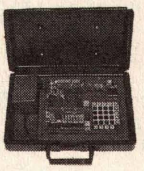

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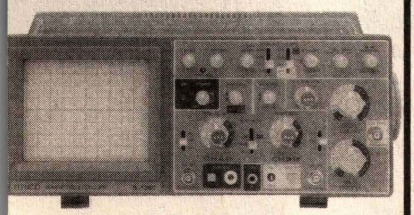

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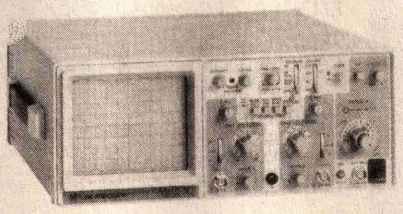

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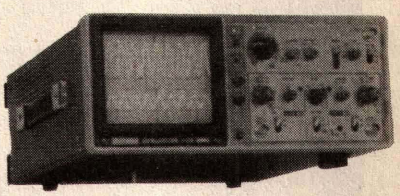

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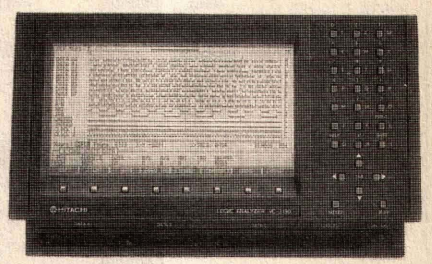
Logic Analysers



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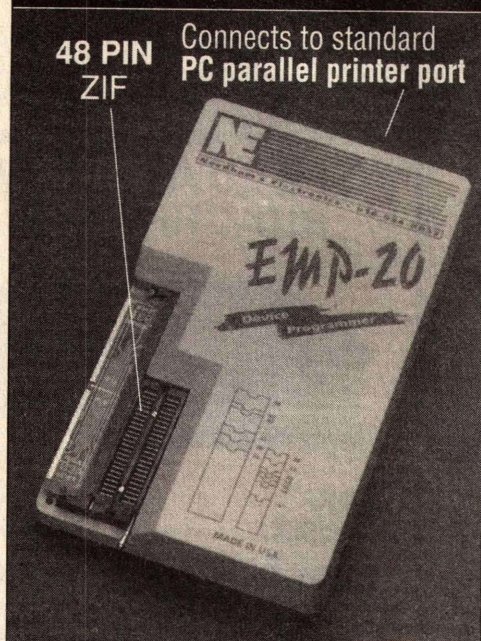

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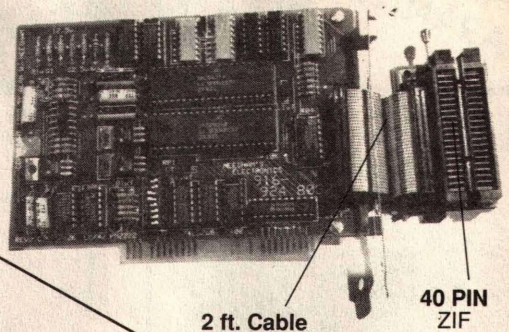

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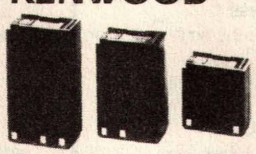
BP83A 7.2v 750 mah
BP84 7.2v 1000 mah
BP85A 9.6v 600 mah
BP85B 12v 600 mah

KENWOOD



PB1 12v 1000 mah **$59.00**
KNB4 7.2v 2200 mah **$59.00**
PB6 7.2v 750 mah **$46.00**
PB7 7.2v 1500 mah **$55.00**
PB8 12v 750 mah **$55.00**

MOTOROLA

HT300 7.2v 1600 mah **$45.00**
HT90 12v 600 mah **$34.00**
HT440 12v 600 mah **$39.00**
MT500 15v 500 mah **$39.00**

RADIUS
P-10 500 mah **$28.00**

SABER
7.2v 1100 mah **$59.00**

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PANASONIC
PVBP80/88 12v 2.3 amps
RCA/HITACHI
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VHS-C
SONY
NP22
NP55/77
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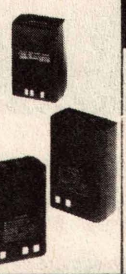


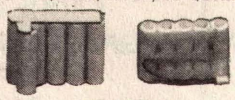
FNB-2 v 500 mah **$21.00**
FNB-2 v 600 mah **$23.00**
FNB-4A
FNB-10
FNB-10S 7.2v 1000 mah **$43.00**
FNB-12
FNB-12S 12v 600 mah **$45.00**

SPECIALS

ICOM-SA/SAT
ICOM-72A CHARGER WITH BP-84 (Equiv.)—3" High
7.2v @ 1000 MAH **$135.00**
or
BP-85B (Equiv.) 3" High
12v @ 600 MAH **$164.00**

INSERTS

KENWOOD
PB-21 **$13.00**, PB-25, 26- **$20.00**



ICOM
BP-3 **$17.00**, BP-5 **$22.00**
BP-7, BP-8

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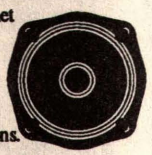


G3209 $4.95

4"x 6"Coaxial

Great for many types of auto or home applications. Features built in piezo tweeter, dust cover and 8 ohm 15 watt peak rating.

G3213 $8.00

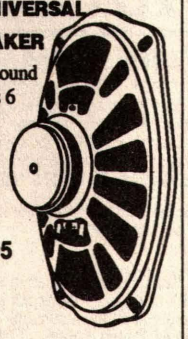
6"x 8" Universal Auto Speaker

Great for replacement or new construction this speaker is rated 8 watts,6 ounce magnet and 4 ohm impedance. Standard mounting for many FORD cars. Has built in dust screen.

G3210 $4.75

6"x 9" Universal Auto Speaker

Universal auto sound speaker features 6 ounce ceramic magnet, 8 watt 4 ohm voice coil and built in dust screen.

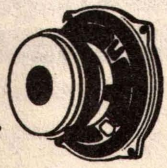


G3211 $5.95

SUPER WOOFERS

5" Super Subwoofers

(Pincussion Mount) Heavy duty in a very compact size! Features 1 1/4 aluminum voice coil, massive 20 ounce ceramic magnet, 4 ohm impedance, 50 watt RMS (75 watt peak) power. Response to 400 HZ vented backplate, air suspension edge and dust screen.



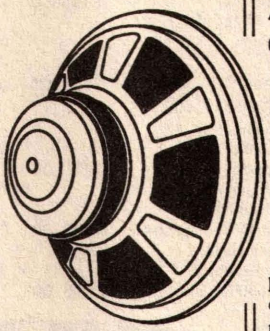
G3212 $21.95

POWER WOOFERS

Guitar, Stereo and Auto Applications

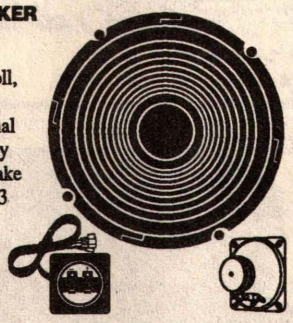
SIZE	RATING RMS Peak	VOICE COIL	MAGNET	STOCK#	PRICE
12"dia	100W 200W	2" 4Ω	30 oz	G3217	$35.00
15"dia	150W 300W	2 1/2" 8Ω	56 oz	G3218	$59.00
*15"dia	200W 400W	3" 8Ω	95 oz	G3219	$100.00

* massive cast frame-this is our most powerful speaker



2 Way 75 Watt Peak Speaker System Components

Consists of a 10" 16 ounce magnet, cloth roll, air suspension, 8 ohm woofer, a 3" square tweeter and a press fit quick connect terminal with 75 watt crossover. These were made by Pioneer for a custom manufacturer. You make your own enclosure and save a bundle. All 3 components for one low price!



G3208 $29.95 SPECIAL VALUE

Misc. Small Speakers

SIZE	IMP	WATT	STOCK	PRICE
1 3/4	32Ω	.15	G3214	$1.00
2 1/4	32Ω	.25	G3215	.89
2 1/2	8Ω	.2	G939	1.29
2 5/8	4Ω	3	G2851	1.50
3"dia	16Ω	.5	G3216	.75
4x6"	8Ω	6	S2208	3.95

SPECIALS

Combo TV/VCR Remote

Hand held remote made by zenith. We just got these in and have no other info except that they have a few scratches on the case. As is.

G2555 $1.00

Copper Clad Blowout

Great for making high quality PC boards. These are standard glass epoxy double sided copper clad blanks. Size is an incredible 12"x12". Each panel is large enough to make many smaller PC boards. A SUPER VALUE.

G2869 $2.00

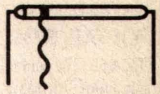
Bright Orange LED

Jumbo T1 3/4 diffused lens, orange LED.

G2554 10/$1.00
100/$9.00
1000/ $70

Strobe Tube & Schematic

Bright xenon tube for making strobe lights. Size: 1.5"

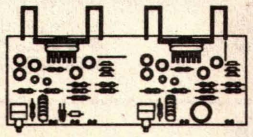


G936 $1.39

BOOSTER AMPS

20W + 20W Stereo Amp Kit

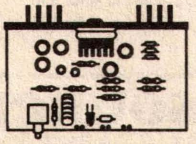
Two seperate high power amps on one PC board put out an incredible 20 watts RMS each. Features low distortion circuitry. Great stereo booster amp for your car sound system. Use with any speakers capable of handling at least 20 watts. Operates on 12VDC. Size of board: 6"x2.25"



C6442 $19.95

20 WATT RMS MONO AMP KIT

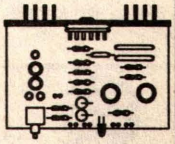
High power amp for various booster applications. Kit features short and open circuit protection and very low distortion (1% or less). Has red LED "on" indicator and will boost any tuner, radio, cassette or CD player to room filling volume! Operates from 12 VDC. Size of board:3.75"x2.1". Complete with parts, PC board and instructions.



Skill Level 2
C6444 $14.95

10W + 10W Stereo Amp Kit

Similar to the 20W+20W stereo amp only this one puts out 10 Watts RMS to each channel. Features one level control that sets level in both channels and red LED "on" indicator. Use this amp with your speakers to boost portable tape players, radios or CD players to room filling volume. Operates from 12VDC. Size of board: 3.75"x2.25". Complete with all parts, PC board and instructions.



Skill Level 2
C6443 $16.95

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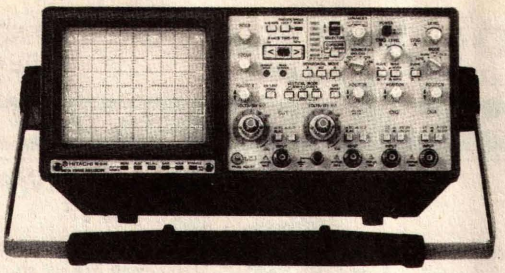

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VC-6025A	2 Ch, 50 MHz, 20 MS/s, 50 MHz repetitive sampling, 2 KW/ch, frequency counter, RS-232 w/HPGL support	2695.00	PRICE QUOTES!
VC-6045A	2 Ch, 100 MHz, 40 MS/s, 100 MHz equivalent sampling, 4K Mem, frequency counter, RS-232 w/HPGL support	3295.00	CALL
VC-6145	4 Ch, 100 MHz, 100 MS/s (1 ch), 4KW Mem, frequency counter, RS-232 w/HPGL support	4395.00	FOR PRICE
VC-6155	2 Ch, 100 MHz, 100 MS/s (2 Ch), 4 KW Mem, frequency counter, RS-232 w/HPGL support	3995.00	QUOTES!

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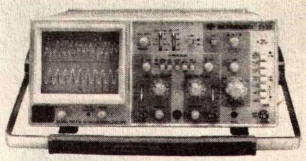

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TEK 7623, 100MHz Storage wuth 7A18 D/T vert. amp, 7B53 T/B.....$995
TEK 7633, 100MHz Storage wuth 7A18 D/T vert. amp, 7B53 T/B.....$1295

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27256, 27C256, 27512
27C512, 27513*, 27C011*
27C010, 27C1001 (1 MEG)
27C020, 27C2001 (2 MEG)
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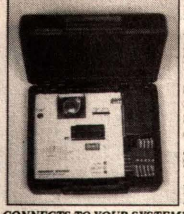
*40 PIN EPROMS *1, 2 & 4 MEG*
27C1024, 27C2048, 27C4096
27C210, 27C220, 27C240



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Covers all hard drive and controller implementations (emphasis on PCs). How to select, interface, initialize, set up, use, maintain, troubleshoot and repair them. How to protect them from mistakes, sabotage, prying eyes and sticky fingers. How to recover damaged and lost files. How to prevent crashes to begin with. Includes software reviews. Loaded with information, advice, tips. **$29.**

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Maintain, troubleshoot, repair, adjust, align floppies Without special equipment or software. **3.5"/5.25"/8", PC/XT/AT/386/486, Apple, Commodore,** etc systems. All floppies need regular upkeep. **$29. DISK DRIVE TUTORIAL:** Theory, practical facts on floppy drives, disks, including many tips, recommendations, formatting, interfacing, FDC, etc. **$19. Both $39.**

AUTOMATIC TELLER MACHINES

ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, include: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, Van Eck, tapping, spoofing, inside job, super-cool, vibration, pulse, high voltage - others. Case histories, law, countermeasures, detailed security checklist, labeled internal photos, figures. ATMs contain up to $250,000 in cash! Recent $350,000 ATM crime spree still unsolved! **$39.**

CREDIT CARD SCAMS

Cardholders, merchants and banks suffer $ Billions in losses annually because of credit card fraud. Describes every known means of credit card fraud and scams. Protect yourself! **$29.**

CONS & SCAMS

Cons & scams fleece Americans of $100+ Billion per year! The most comprehensive survival manual on cons & scams of all kinds - from the classic to the high-tech. Details on 100s and their many variations. Protect yourself! **$29.**

STOPPING POWER METERS

As reported on CBS "60 MINUTES": **How certain devices can slow down - even stop - watthour meters - while loads draw full power!** Device simply plugs into one outlet and normal loads into other outlets. Also describes meter creep, overload droop, etc. Plans. **$29. THE I.G. MANUAL:** External magnetic ways (applied to the meter itself) to slow down and stop watthour meters while drawing full loads. Plans. **$19. KW-HR METERS:** How watthour meters work, calibration, error modes (many), ANSI Standards, etc. **Demand and Polyphase Meters.** Experimental results to slow and stop meters by others. **$19. Any 2, $36. All 3, $52.**

HIGH VOLTAGE DEVICES

HV devices plans: **Stun Gun, Taser, Prod, Cane, Flasher, Blaster, Zapper, Audio/RF/ Radar Jammer, Jacob's Ladder, Plasma & Van de Graaff Gens., Fence Charger, Geiger Counter, Ozone Gen., Fish Stunner, Plant Stim., Kirlian, more! Shocking! $29.**

UNDER ATTACK!

Electromagnetic Interference and Electronic Weapon Attacks can cause: Cancer, birth defects, and profound psychological, neurological, cardiovascular and immune system disorders! Destructive to people, animals, plants, equipment! Includes ACTUAL CASES OF EM ATTACKS ON PEOPLE (we investigated) - more common than believed! Includes how to verify and pinpoint EMI and electronic attack sources, and specific countermeasures. $29.

EM BRAINBLASTER

Tutorial and plans for powerful **ELECTROMAGNETIC WEAPONS and LAB DEVICES.** Optimum circuits, freqs, waveforms, duty cycles, intensities. Comprehensive. **$29.**

RADIONICS MANUAL

Exciting electrical, electronic and electromagnetic therapeutic, diagnostic and preventive devices (mostly experimental). History, descriptions, plans (dozens), availabilities of **Radionics Devices** from early to modern. While drugs cost $ Hundreds, electricity costs pennies! **$29.**

ROBOFONE AUTODIALER

Powerful, versatile, menu-driven ***Wargames*** autodialer lets you dial any quantity (up to 10K) or mix of local/long distance numbers in any order, over any length of time, whether busy or answered (your choice) and log the times, commands and results to monitor, printer and-or disk. Quick-dial directory of up to 600 numbers. BUSY redial options. Direct modem command and control. All Result Codes, including VOICE and RINGING. Optional shell to terminal program upon CONNECT. Exit to menu or DOS (for batching). **Manual + Disk* $29.**

SOFTWARE PROTECTION SYSTEM

Unique system that highly discourages costly software piracy while not interfering with legit archival copies. No known way to defeat. No special equipment required. Simple and automatic to install on your distributed software. Compatible with all other copy-prevention systems. **Manual + Disk* $59.**

SECRET & SURVIVAL RADIO

Optimum survival and security radio equipment, methods, freq allocations and voice/data scrambling/encoding. Includes small receivers/transmitters, telemetry, antenna optimizations, remote monitoring and control, security, surveillance, and ultrasonic, fiber-optic and infrared commo. 70+ circuit plans, tables. **$29.**

STEALTH TECHNOLOGY

Police radar is fascinating! It also has error rates of 10-20%! Every known error mode - stealth method and material used to minimize radar reflections - tactic and strategy to fight unjust radar tickets (that cost you $100s in insurance and risk cancellation) - methods to detect and jam signals - fully described! **$29.**

ROCKET'S RED GLARE

How to design and build solid-propellant amateur and survival rockets. Emphasis on formulation, manufacture, installation of propellants, motors, igniters, etc. Includes list of commonly available materials, and the design of launch pads and test beds and their electronics. **$29.**

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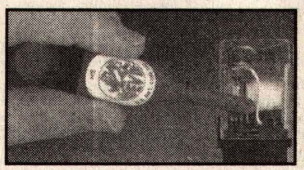
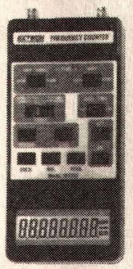


MAGNETIC PROBE SENSES MAGNETIC FIELDS

This safe non-contact probe allows you to trouble-shoot AC and DC solenoid-operated devices, relays or any device using a coil. Also detects transient pulses as fast as 10mS and identifies north and south poles. Place the probe close to the coil and if the LED is on the device is energized. Probe operating frequency is DC-400Hz.

$179.00
Reg. $199.00
Model ZC381200



HANDHELD 1.25GHz FREQUENCY COUNTER

Microprocessor-based counter measures frequency from 10 Hz to 1.25GHz and period from 0.1µs to 100ms. Includes data hold, min/max/average readings and relative frequency measurements. Complete with 4 AA batteries, manual and 1-year warranty.

$79.95
Reg. $95.00
Model RCDS1
Tool Case

$219.00
Reg. $298.00
Model R53-CDS1
Tool Kit

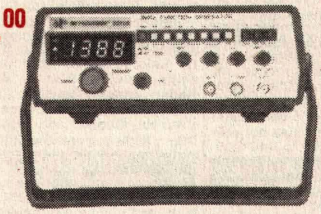
DOUBLE-SIDED CORDURA® CASE

One side has 45 pouches to hold your tools, the other side has a built in clipboard to hold a legal size pad of paper, a document pouch and 3 pockets to hold small items. The case also features 3 pockets on the outside of the case.

SERVICE SPECIALIST TOOL KIT

56 piece tool kit includes the case above plus commonly needed nutdrivers, hex drivers, screw drivers, pliers, cutters, wrenches, crimping tool, wire stripper, soldering tools and more. (DMM is not incl.)

$249.00
Model Z3011B

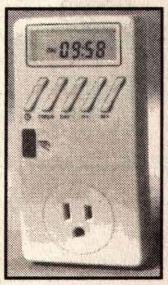


BK PRECISION

2MHz FUNCTION GENERATOR

Features a 4-digit frequency counter display. Operates at 120/220/240VAC 50/60Hz. Complete with power card, one cable BNC to insulated clips, manual and 1-year warranty.

$55.00
Reg. $59.00
Model ZC375370



PROGRAMMABLE DIGITAL TIMER

Provides up to 6 on and 6 off settings per week with a minimum switch time as low as 1 minute. Plugs into 3-prong 110VAC outlet and has battery backup (AAA battery incl) to prevent programs from being cleared during power failure. Rated at 15amps. UL listed.

$409.00
Reg. $499.00
Model ZV212

HITACHI

20MHz DUAL CHANNEL OSCILLOSCOPE

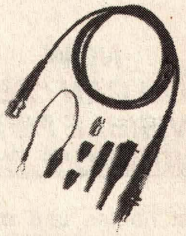
Panel layout is color-coded to identify functions easily. Sensitivity 1m/div. Complete with probes, operator's manual and 3-year warranty.

$39.00
Reg. $45.00
Model ZSP100

X1, X10 SWTICHABLE OSCILLOSCOPE PROBE

Monolithic probe features a 100 MHz bandwidth, a 3.5ns risetime, a wide compensation range (10pF to 60pF), a break-resistant center conductor and a sharp heavy-duty tip. Complete with spring hook, BNC adapter, IC and insulating tip and trimming tool. Cable length is 1.5 meters.

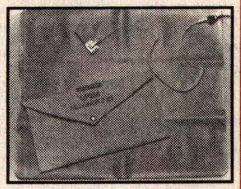
$36.00
Reg. $42.00
Model ZP200



X10 OSCILLOSCOPE PROBE

200MHz monolithic probe provides superior performance with a risetime of less than 1.5ns and a sharp pulse response. Complete with sprung hook, trimmer tool, 6" ground line, BNC adapter, IC and isolating tip. Cable length is 1.2 meters.

$39.00
Model Z16420



ESD FIELD SERVICE KIT

Kit includes a blue static-dissipative vinyl work surface (18"x22"x0.30") with two female snap fasteners, a common-point grounding cord (15'), one adjustable wrist strap with a 1 megohm resistor, a 6' cord and a 7"x13" storage case.

$109.00
Model Z815
BK PRECISION

HAND-HELD PARTS TESTER

This 2000 count, 3½ digit LCD display meter tests capacitance (20mF), resistance (20MΩ), transistor hFE, SCRs, diodes, LEDs and batteries. Comes with 9V battery, manual, test leads and 1-year warranty.

$24.00
Model ZPB1

AUDIBLE CONTINUITY TESTER

Tester gives a clear audible sound on point-to-point continuity and is suitable for Go/No-Go test for wires, cables, LEDs, switches, diodes, transistors, etc. Complete with test probes and detachable alligator clips. Operates on 9v battery (not incl.).

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Beckman Industrial **$159.00**
Model ZRMS225

4 DIGIT TRUE RMS DMM

- 0.25 % accuracy
- 41 segment analog bargraph
- 3-year warranty

Full-function, auto-ranging DMM with 4 digit, 10,000 count resolution measures DC voltage and current, resistance and true RMS AC voltage and current. It features a continuity beeper, diode test, an Auto Min-Max mode, a relative mode and a probe hold mode. Comes complete with manual, test leads, battery(9V), and protective holster.

$59.95
Reg. $80.00
Model RIM5 Tool Case

$299.00
Regular $365.00
R22-IM5 117 Pc. Tool Kit

THE PROFESSIONAL'S TOOL CASE

- Case top has built-in document holder
- Case bottom is partitioned into 3 areas
- Two removable pallets hold over 60 tools

A handsome black case to organize and transport your valuable tools and instruments. This is the same quality case used by thousands of professional field engineers. Case is made of high impact polypropylene, and has snap-action key locks and a padded handle.
Size: 17 1/2" x 12 1/2" x 5".

117-PC. PROFESSIONAL FIELD SERVICE KIT

The complete kit comes with the tool case described above and a complete selection of quality, brand-name tools including Diamond, Xcelite and Weller. The kit includes screwdrivers, pliers, tweezers, cutters, wrenches, alignment tools, hex driver blades and a crimping tool, wire stripper, soldering iron & supplies, socket set, penlight, inspection mirror, hammer and more.

Lifetime Guarantee: Any tool that fails under normal use will be replaced free of charge.

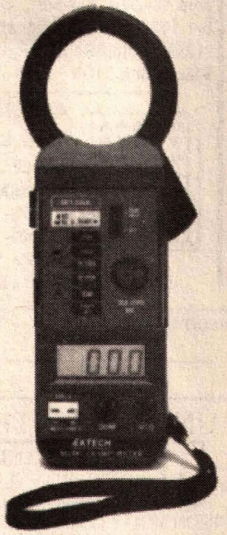
$109.00
Reg.$139.00
Model R380912

$129.00
Reg.$159.00
Model R38091F

DCA/ACA CLAMP METER

Functions as 3 1/2 Digit DMM

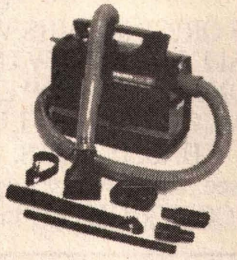
Transformer jaws measure up to 400A AC/DC and a peak-hold function provides recall of AC or DC current surges. As a DMM it measures AC voltage, DC voltage, AC/DC current and resistance. The meter has the following ranges:ACV: 750V; DCV: 200mV, 200V; DCA/ACA; 200A,400A; Resistance; 2000 ohms Resolution down to 0.1mV, 0.1A and 1ohm. Comes complete with test leads , battery, carrying case and 1-year warranty. Model R38091F also has a built-in temperature function, 0-1400°F.



$149.00 Reg. $183.20
Model ZC2093

SERVICE VACUUM CLEANER

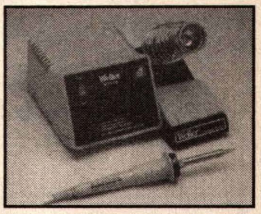
Features a powerful 2.2 peak HP motor, easy change double-layer filter bag, shoulder strap and built in handle. Toner-safe. Complete with a 6' Tuflex hose, dusting brush, crevice tool and brush, tube adapter, snorkel tube and small dusting brush. 12"x11"x5". 8 lbs.



$99.00 Reg. $128.65
Model RWTCPS

TEMPERATURE CONTROLLED SOLDERING SYSTEM

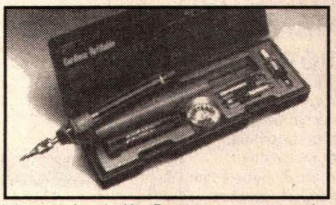
Widely used in industry. It maintains a constant tip temperature of 700°F. Grounded tip protects components from voltage spikes. Comes with power unit, iron, stand, sponge and 700°F tip.



$49.00 Reg. $58.30
Model ZP1KB

BUTANE POWERED SOLDERING TOOL

With cordless convenience this 4-in-1soldering tool converts from a solderingiron to blow torch, hot blower or hot knife. Butane gas powered. Complete with tips, sponge, iron stand and carrying case.



$49.95
Model Z7201F

DIGITAL THERMOMETER

Measures 0° to 159°F, has a hi-lo limit setting, an accuracy of ±1° and a built in clock function. ABS covered probe is suitable for air/immersion applications. 1.5V battery incl. 4oz.

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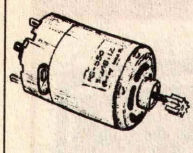
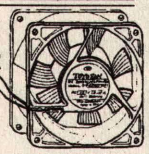
MABUCHI R/C HOBBY MOTOR



#RS-550. Wide Range: 4 to 15 VDC. Perfect for R/C planes or cars using either 7.2V or 14.4V Nicad. Approx. 12,000 RPM. Motor: 2 1/4 In. X 1 7/16 In. Dia. $2.95 or 4/$10

12VDC COMPUTER FANS



Most common size ! TOYO. 3 1/8 sq. X 7/8 In thick. $6.95

SUPER SPEAKER DEAL !

8 Inch Round Woofer. 4 Ohms - 20 Watts ! $4.95 ea.

8032 MICROCONTROLLER

Speed: 12MHZ. 44 Pin PLCC package. Mfg. by Signetics. 99¢ 11.059 MHZ crystal -- $1.25

SIEMENS 4 DIGIT ALPHA - NUMERIC LED DISPLAYS

4 Big 5 X 7 (.27 Inches) Displays with built in CMOS logic. 96 character ASCII format. 8 bit TTL compatible bidirectional Data bus. End stackable for any length display. Overall length package is only 1.4 inches. Very easy to use, requires only an ASCII input from a microprocessor. Built inROM, memory, decoders, multiplexer, and drivers !!! Pins fit a standard .600 In. wide IC socket. W/Data

#PD 3435 $5.95 ea. or 5/$24

Computer Grade Caps

15,000 MFD 75 VDC

Small size, mfg. by Cornell Dubilier. 2 In. Diam. X 4 1/4 In. Tall Part # DCM 153U075BC2B Perfect for audio amps or regulated power supplies. 1990 Date Code.

$4.95 ea. or 10 for $35

NICHICON HIGH VOLTAGE ELECTROLYTIC CAPS !

Used in switching power supplies, Also perfect for vacuum tube circuits. VERY RARELY SEEN IN SURPLUS! Factory Fresh !

#1 100 MFD / 450 VDC 40 mm X 24 mm. 85° C. $1.29

#2 330 MFD / 250 VDC 45 mm X 20 mm. 105° C. $1.59

RADIAL LEADS

#3 330 MFD / 400 VDC 45 mm X 30 mm. 85° C $1.95

#4 330 MFD / 450 VDC 50 mm X 35 mm. 85° C $2.79

HI-TECH DISPLAYS

OPTREX LCD DISPLAY

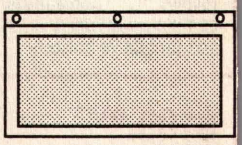
2 Line X 16 Characters. 7 Bit ASCII Input. #DMC16207H w/ Data. $7.95

SIEMENS SMART LED DISPLAY

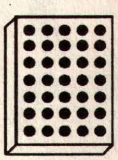
#DLO-7135. 5X7 Red. With built in logic ! Requires only a chip select and an ASCII input. Operates on 5 VDC. 1 Inch tall. w/ Data. New Units ! Displays entire 128 char. set ! PRICE CUT ! $2.95 ea.

EPSON LCD GRAPHICS DISPLAY

640 X 240 dots - Super twisted nematic type. Built in drivers - 4 bit TTL interface. Viewing area 10-7/16" X 4-5/8". Overall 11-3/8" X 6-1/16". 14 pins for signals and power (+5V, -12V). Complete 27 page manual. $19.95 or 6/$100 #EG-7004S-AR



NOT FOR BEGINNERS !



ALPHA-NUMERIC RED LED ARRAY

7X5 LED Matrix. For moving message signs, Etc. By IEE. #2057 - c/c rows. #2058 - c/a rows. 2 X 1.5 In. w/Data. Your Choice: $2.95 ea. or 8 for $14.95

SIEMENS 4 DIGIT LED DISPLAY

Red or Green. With built in logic. 5X7 Matrix. Full ASCII Input. 5 VDC. .2 In. char. With Data. #PD2435 - RED - $3.9 #PD2437 - GREEN -$3.9

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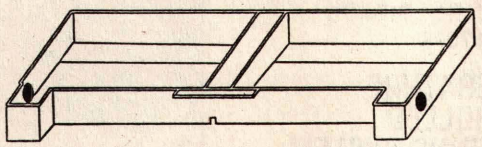
A USEFUL AND WORTHWHILE TOOL for the * *PROFESSIONAL * *STUDENT * *EXPERIMENTOR

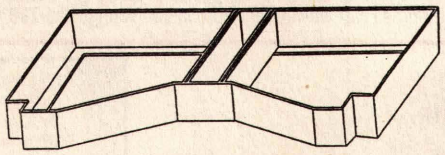
A PRECISION MOLDED, HIGH IMPACT, CLEAR PLASTIC TOOL THAT REPLACES THE VIDEO CASSETTE WHILE DIAGNOSING THE PROBLEM. THE VCR OR CAMCORDER WILL FUNCTION IN ALL MODES AND THE MECHANISM WILL BE OPEN FOR INSPECTION, MEASUREMENT & ADJUSTMENT

VHS - SVHS - VCR's & CAMCORDERS



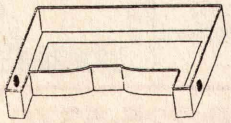
VT-103 $9.95

BETA I II III & CAMCORDER



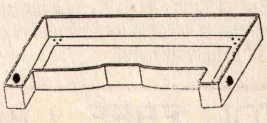
BVT-100 $9.95

VHSC - SVHSC CAMCORDERS



CVT 100 $9.95

8MM - VCR's CAMCORDERS



EVT 100 $9.95

NOTICE !!

THE ORIGINAL VHS VU-THRU TOOL WILL WORK IN ALL VCR'S, NEW UNITS OR OLDER UNITS- FRONT LOAD,–TOP LOAD,–SIDE LOAD, AND CAMCORDERS. INCLUDING THE DISCONTINUED "G" CHASSIS VCR'S.

(see page 9 of our up-dated ILLUSTRATED & COPYRIGHTED instruction manual)

INSTRUCTION MANUAL

HOW TO:

* Clean Video Heads pg 3
* Check tape end sensors pg 5
* Renew drive wheels pg 4
* Adjust loading posts pg 7
* Renew pinch roller pg 6
* Clean erase & audio heads pg 7
* Check Spindle sensors pg 8
* Adjust tape guides pg 9
* AdjustTracking head pg 7
* USE IN "G" CHASSIS pg 9
* PLUS MANY TIME SAVING TIPS

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5 HEAD CLEANING SWABS
1 OZ. HEAD CLEANING FLUID
1 RUBBER RENEWING TOOL

VISA

MASTERCARD

ANY ONE TOOL $ 9.95 ea. $ 3.50 S&H $ 13.45 total

ANY TWO TOOLS $ 19.90 WE PAY S&H

ORDER ALL FOUR $ 29.85 WE PAY S&H

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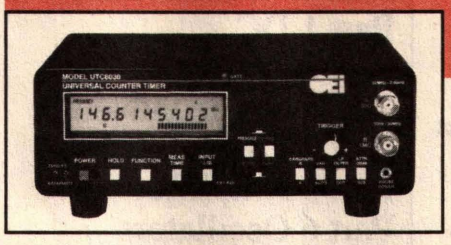
The world's finest hand held multifunction counter – incorporates many unique functions usually found only in very expensive bench models. esigned for virtually every measurement pplication from near DC through Micro- ave including measuring RF transmission equencies at the maximum possible stance. The 3000 is also the world's first andiCounter® with Period, Time terval and Ratio measurement pability. **$259.**

R10 FM Communications Interceptor™

ALL NEW TECHNOLOGY!! The Interceptor follows & locks on even when frequency changes and intercepts ALL FM Two-Way Transmissions without gaps in coverage. It does not have to tune through RF Spectrum to capture signals. FCC Classified as ommunication Test Instrument – crease your RF Security!! **$359.**

20 AM nterceptor™

EW! The R20 is both a nsitive RF signal rength meter (for ALL F signals) and a near eld AM receiver. The 10 gment LED bargraph sponds with nominal dB increments to RF gnal level received rough the built antenna. **119.**



Bench/Portable Multifunction Counter Model 8030

10Hz - 3GHz extremely High Sensitivity, High Resolution and Accuracy, includes a Bargraph, ± 1PPM TCX0, Two Inputs, Adjustable Trigger Level, Trigger Variable and Hold Button **$579.**
Optional ± .1 TXCO: $135.

HandiCounter® Model 2810

Our full range counter with bargraph 10Hz to 3GHz. Ultra-high sensitivity, 4 fast gate times, outstanding quality–low, low price. **$199.**

Handi Counter® Model 2300

The Original Pocket Sized Counter. 1MHz to 2.4GHz – 8 digit LED. Maximized Sensitivity, ± 1ppm TCXO. Includes Hold Switch, NiCads and Charger/ Adapter! **$99.**

APS104

Our Active Preselector allows you to pick-up transmissions or frequencies at 10 times the distance. Use with our HandiCounter® or R-10 Interceptor™ 10MHz - 1GHz Tunable over 5 octaves **$995.**

Tone Counter Model TC200

NEW! Ideal companion for use with the R10 FM Communications Interceptor™ to measure sub audible signalling tones off the air. The TC200 can also be used with scanners and communications receiver to monitor sub audible tones. **$179.**

ACCESSORIES

Vinyl Carry Case

CC12 - Padded Black Vinyl carrying case for 2300 size LED Counters ..... $ 12

CC30 - Padded Black Vinyl carrying case for 3000 size LCD counters. ..... $ 15

Antennas

TA100S Telescoping Whip Antenna ..... $ 12

Antenna Packs:

Ant-Pak 1 (includes RD27, RD800, TA100S – Save $11) ..... $ 65

Ant-Pak 2 (includes five assorted rubber ducks, 27-1000MHz – Save $32.) ..... $ 99

Probes

P30 - Counter/Oscilloscope probe - for direct coupling to signal sources or circuit test points. 1x/10x, switchable ..... $ 35

P101- Low-Pass probe attenuates RF noise from Audio frequencies. Has two stage low pass filter. ..... $ 20

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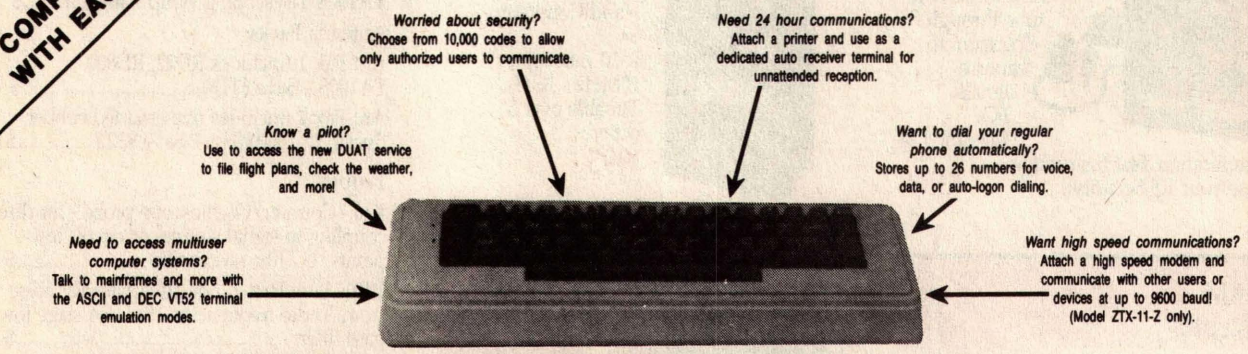
Answer: With all these features and the low price, everyone!



- ASCII, DEC VT52 emulation
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- Parallel printer port
- Phone #, dialing sequence storage
- Changeable security access code
- Switch for single or multi-line phone
- RS-232 port (ZTX-11-Z only)
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- New in original box with manual

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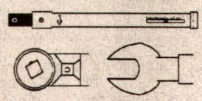
CIRCLE 225 ON FREE INFORMATION CARD

HSC leads the way to savings with the best in Silicon Valley Exotica!

Torque Wrench -- Industrial Strength!

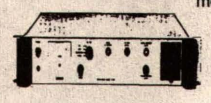
Just in -- industrial torque wrenches by Mountz. These brand new items are calibrated from 20 to 200 kgf.cm and feature "click" action torque control. Snap-fit heads include useful 3/8" ratchet, 11/16", 30 mm and 13mm open ends, and 17mm box end.



HSC# 13655 Set only $19.95

TV Modulator -- Industrial Strength!

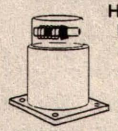
Just what you needed to finish that home television station...this Channel 2 modulator by Telemet! These used units accept a composite video signal and audio and provide a VHF television carrier (channel 2) modulated by the input signal. 19" Rack mount chassis. Schematic included. Full Manual available, $5



HSC#13657 $59.95

Test for Shock -- Industrial Strength!

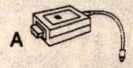
Here is an unusual item...a resettable G-force gauge! This high quality item is used to detect mechanical shocks in excess of 15 G's...perfect for determining if your shipment was dropped by the shipping company, or use to calibrate your rocket sled! Measures 2" tall on a 1 5/8" square base. Detailed data sheet enclosed. **HSC# 13656 $5.95**



More from HSC's Project Locker...

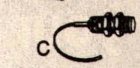
We've scoured our shelves once again for rare & unusual parts that will get you thinking of the many uses to which they may be put. Many items you just won't find anywhere else, and our prices will encourage you to dream up new projects!

A. Macintosh peripheral device adaptor converts older Mac 128 & 512 style peripherals (9-pin D conn.) to the Mac Plus and higher Mini-DIN connector. Requires 15-17 VAC input (use HSC# 12916 16VAC adapter, $3.95 and HSC# 206B 3mm plug, $.59) **HSC #13001 $5.95**



B. Heatsink with complementary Darlington Pair transistors measures 3" x 6.25" x 1", has 2N6031 (NPN) and 2N6058 (PNP) already mounted. 80V, 12A, hFE = 750 to 18000 @ 6A. **HSC#9677 $5.95**

C. Microswitch 103SR11A-1 Proximity Sensor -- Hall-effect detector operates on 5 VDC 4 mA, sources 3.5 VDC max 20mA in presence of greater than 25 Gauss magnetic field. .43" dia. x 1" (nuts not included) With spec. sheet. **HSC #5319 $.99 ea**



D. Tiny switching power supply, perfect for powering a single 3.5" hard disk drive. 2" x 6.25" x 1.25". Made by Skynet, used, tested good. Selectable 110/220VAC input, 5VDC @ 2A and 12VDC @ 1.5A output. **HSC #12758 $17.50 ea**

E. Nine-digit, eight decimal point numeric LCD with solderable connection strip. No funny sockets needed! .5" high digits, overall size of display .75" x 3". Pinout included. **HSC #13518 $1.95 ea. or 10/$15.00**

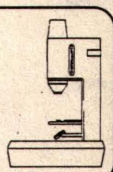
F. Miniature Toggle Switch -- SPDT 125VAC 6A or 250VAC 3A Standard type on-on switch, solder eyelet terminals. Any hobbyist should have at least a handful in his parts bin! Now you can afford it... **HSC# SW104 10/$6.95**

G. High Value Capacitor -- .047 Farad (yes, that's Farad) at 5.5V in a package only .5" dia. and .3" tall. Good for CMOS memory back-up, etc. Made by Sohio. **HSC# 10771 $.29 ea. or 10/$2.49**

H. Leviton 6608 touch-activated dimmer control -- Make any metal surface or contact dim an incandescent lamp (up to 150W) simply by touching it! UL Recognized 120VAC dimmer module has three connections: line, load and touch contact. Think of the applications! 1.5" x 1.5" x 2.75" **HSC# 13037 $5.95 ea**

Perestroika Fallout...Soviet Science Collector's Items!

History on the march! Empires crumbling! Eager young scientists being trained for the new world order! We took advantage of the changing world scene to bring you these unique items that are also great values...Russian (formerly Soviet) microscopes! The manual calls them training microscopes, we would probably call them student-grade instruments, although they are not toys. They are both biological (illuminated from below via mirror) microscopes, for transparent specimens. The one on the left is of metal construction, has two objective lenses (8x, 20x) and three eyepieces (7x, 10x, 15x). A recent volume purchase allows us to lower the price to $59.00. The one on the right is made of plastic, with fixed lenses giving 60x overall magnification. The optical assembly will store in its own base, giving a lightweight, compact (5" x 9" x 1.5") package perfect for carrying in a backpack for field trips. It comes with two specimen jars, tweezers, slides, etc. that also store in the base. The quality and workmanship on both units are surprisingly good, given the stories we've heard of Soviet labor woes. Now you can own a piece of history, or just an inexpensive, decent microscope.



HSC# 13065 $59.00 **HSC# 95062 $19.95**

For your IBM-Comaptible computer...

1. Replacement Fan -- Is your computer working fine, but just noisy? You would be surprised at how much dust gets sucked through the power supply. This gums up the bearings of the fan, which then starts to howl. Don't replace the power supply, just change out the fan! Brand new 12 VDC .20A fans, 3 1/8" square body with mounting holes on 2 13/16" centers. **HSC# 13712 $9.95**

2. Western Digital 16-Bit (AT) Hard/Floppy Controller with SIO, PIO ports -- Save slots, save money! WD1003S-WA4 controller will handle two MFM hard drives at 2:1 interleave, two floppy drives (up to 1.44 MB) and also gives you Serial and Parallel Ports. Drive cables included, no manual but installation is typical procedure for AT's. **HSC# 13659 $19.95**

Solar Stuff for the Sunshine-Savant!

Check out these great items that work on free energy! Go solar & save!

1) **Solar Battery Charger** -- Small unit (2.5" x 4.5" x 1.5") has hinged lid with solar cell array for optimum sun angle. Can charge two AA or C Ni-Cd batteries (not included). LED indicates optimum charge rate. **HSC#80050 $12.95**

2) **Solar Rechargeable Flashlight** -- perfect for camping, emergencies...Never needs batteries! 2.5" x 1.25" x 3" fits in purse, backpack. **HSC#80048 $11.95**

3) **4-Power Radio** -- Good-sounding AM/FM radio has solar panel for daytime use, or its internal dynamo can be cranked to charge internal energy source for up to a half-hour of listening time! Also runs off regular AA batteries or DC Adapter (neither included). Great for emergencies, power outages, camping, etc. 3" x 6" x 1.5" You may never buy batteries again! **HSC#80051 $29.95**

4) **Solar Education Kit** -- includes small solar cell (1.75" x 3" x .25"), booklet, small DC motor, fan blade, spinner disks, stickers, etc. Good for child's school or science fair project. **HSC #80017 $9.95**

5) **Solar Musical Keychain** -- plays melody in bright sunlight, also has LED flashlight so you can find that keyhole in the dark! **HSC # 80053 $4.95**

Attention: Robot Builders & Hobbyists!

A. Just in! 12VDC two-speed reversible motors, perfect for your own personal R2-D2's locomotion! These motors are 3" dia. x 4.5" long with a .5" long shaft. They will provide up to 30 oz.-in. of torque at 2700 RPM, unloaded speed is closer to 5000 RPM. Depending on load they draw anywhere from 5 to 9 amps. The .31" (5/16") dia. shaft is cut with gear teeth, but you could still put a pulley or gear with a set-screw on it. Generous 33" long leads are color-coded for easy hook-up. Connection diagram and torque curve chart provided. These motors are new, but slightly dusty. **HSC# 13617 $7.95 ea.**

B. 12VDC SPDT Relay -- just the thing for controlling the above motor (in fact, they are both left-overs from a camper-jack system). C.P. Clare GP3R211ND1000 relay is rated at 10 amps, uses solderless quick-connect tabs, and has handy mounting ears. **HSC# 13618 $4.95 ea.**

C. Heavy duty Coil-cords -- Two types available. Makes connections to moving fixtures easy! Rugged SJO insulation, slightly dusty. These are not easy to find, and only limited quantities are available!
HSC# 13620 20AWG, 5 cond., 5' stretches to 24' **$5.95**
HSC# 13621 18AWG, 4 cond., 4' stretches to 25' **$7.95**

D. Stepper Motors -- Two types , both 12VDC, sorry, no docs on either one yet... we'd appreciate info if you have it!

At left, Howard Ind. Model 1-19-4200, 3.6° per step, 1.75" x 1.75" x 1.75" **HSC #13036 $7.50**

At right, Minebea Co. "Astrosyn" Model 23LM-C331-03, 1.8° per step, 2.25" x 2.25" x 3" with bracket (not shown) **HSC #13594 $4.95**

Now Available...New HSC Catalog!!

Finally, it's here! Months in the making, copiously illustrated,... our new 48-page catalog, listing thousands of electronic essentials, is now available! Send $1.00 (or get one free with any order) and thanks for waiting patiently!

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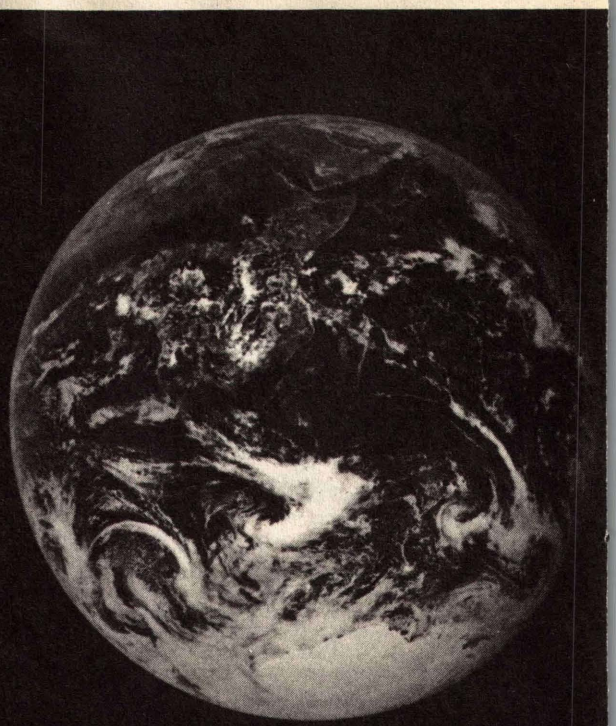

IF YOU'RE NOT RECYCLING YOU'RE THROWING IT ALL AWAY.SM

A little reminder from the Environmental Defense Fun that if you're not recycling, you're throwing away a lot mo than just your trash.

You and your community can recycle. Write the Envir mental Defense Fund at: EDF-Recycling, 257 Park Avenue South, New York, NY 10010, for a free brochure that will te you virtually everything you need to know about recycling.

EDF TM Ad Counc

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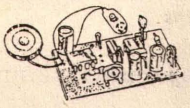
RAINBOW KITS



RADAR SIGNAL DETECTOR

If you think that a sensitive radar detector is a complicated piece of equipment, take a look at this new kit. This simple, yet effective, detector circuit can be built in less than an hour and can be tuned to respond to signals between 50MHz to 500GHz. It's a fun kit to build and play with. A cigarette lighter plug is included. Size 1"x¾" operates on 9 to 15v DC.

KIT RSD-1 **$12.95**

STROBE LIGHT

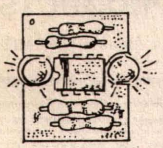
If you need an attention getter, or warning light, you need the strobe light kit. Use it for emergency light for autos, for model planes or radio towers. Even use it on your bicycle. Operates on 6 or 12v DC and has a variable strobe rate.

KIT ST-1 **$8.95**

DIGITAL THERMOMETER

Have you ever wanted to tell temperature changes fast & accurately? The DT-1 kit will turn your digital volt meter into an accurate digital thermometer with .1 degree resolution. It gives you a 250 degree window with a range from -40F to 300F degrees. It has a remote sensor .25" sq. that can be mounted many feet from the meter if need be.

KIT DT-1 **$8.95**



BLINKEY LIGHTS

Want to attract attention? These kits are perfect for decorating name tags, lighting up your hat, or flashing lights for your model trains. Some people use them to simulate a burglar alarm for autos. Put it in a box, set it on your dash and it looks like the real thing. Each kit contains two LEDs that alternates flashing. Operates on a 9v battery. Size .5"x.5"

KIT RB-2 **$3.45**

CAPACITANCE METER

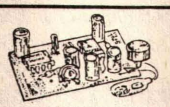
This easy to build kit will turn your digital volt meter into a CAPACITOR METER. Turn that junk box of unmarked capacitors into a fortune. Measures capacitors from (2pF to 2.2uF. Operates on a 9v battery. Size 1.75"x2"

KIT CA-2 **$12.95**

WIRELESS FM MIKE

Small but mighty .8"x1" PCB, will really stomp out a signal well over 400 yds. This is a buffered wireless mike that operates on 80 to 120 MHz FM. Comes complete with a microphone, and 9V battery connector. Operates on 6 to 12v DC.

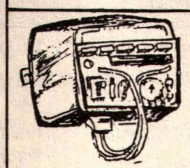
KIT WM-1 **$12.95**



SUPER SNOOPER-BIG EAR

Use this BIG EAR amplifier to listen through walls, hear conversations across the room. Beef up the sensitivity with a parabolic reflector and hear blocks away. Due to the size, the BIG EAR can be hidden about anywhere. Use the earphones from a pocket transistor radio to listen. Makes an ultra-sensitive intercom. Can also be used as a general purpose 1.5W amp. We supply a mini-microphone in the kit. You can also use any 8 to 45 ohm speaker. Operates on 6 to 12v DC. Size 1"x1.75"

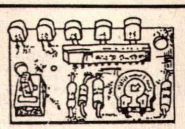
KIT AA-1 **$10.95**



AC LINE MONITOR

This is something every computer user, photographer, or anyone that must maintain a safe usable AC line voltage should have handy. Monitor the voltage of your motor home's 110v AC generator inside the motor home. Every technician's bench needs this item. The AC line monitor will indicate, with multi-color LEDs, what voltage is being distributed to your equipment at that particular outlet.

KIT LM-110 **$10.95**



12V BATTERY MONITOR

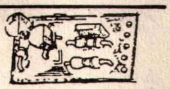
Have you ever been in your car, boat, or camper — you try to start your motor but the battery is dead? The BATTERY MONITOR kit uses the cigarette lighter plug outlet to monitor the true battery voltage. Multi-color LEDs indicate the voltage in 1v steps from 11v to 15v, green means great, yellow is good, and red — call the tow truck or get out the oars. Size 1.2"x1.75"

KIT LM-12 **$5.95**

PHONE BUG

Small but mighty, so small it fits anywhere. Telephone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances away. Variable tunes 70MHz to 130MHz. It can also be used to make any phone a speaker phone. Size .55"x1".

KIT TEL-B1 **$10.95**



PHONE RECORDING SWITCH

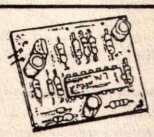
This telephone line powered switch is small enough to install anywhere only .9"x.6". Every time someone picks up the phone the tape recorder will record both sides of the conversation automatically. Use it in your office to record all phone conversations so you don't lose that important address you wrote on the back of an envelope.

KIT TEL-SW 1 **$10.95**

BUSY PHONE LIGHT

Add this little kit to any or all of your phones. When any extensions are in use the LED will light. Uses a 9v battery. P.C. Board 1"x½". Complete with etched & drilled PCB, all parts and schematics.

KIT TEL-LIT-1 **$9.95**



VOICE ACTIVATED SWITCH

This vox can be used to operate a tape recorder, ham radio, CB radio. Use it to turn on an alarm. The output can operate a load up to 100ma. It will operate a relay, lights, motor, or LEDs. What could you do with a sound activiated switch? Size 1.5"x1.25"

KIT VOX-1 **$6.95**

LIE DETECTOR

This kit can be great fun at parties. Lie and an audible tone will change, the more you lie the more the tone changes. When you lie your palms & forehead sweat. This kit allows you to measure these changes. Only a very slight amount of change will cause the tone to increase in frequency. Operates on 6 to 12v DC. Size

KIT LD-1 **$9.95**

LASER KITS

Laser Switching Power Supply Kit, input 12V DC .75-1.25A. Output 2 to 3 KV at 3-4.5 MA, trigger voltage of approx. 8-10 KV. Complete with 6.25" x 2.25" printed circuit board, schematic and all the parts.

LPS-1 ..... **$59.95**

1MW Laser Tube, NEW Mini He-Ne 1.125" dia. x 5.75" long, perfect for experimenters and laser projects. Works great with above power supply LPS-1.

L1MW-1 ..... **$39.95**

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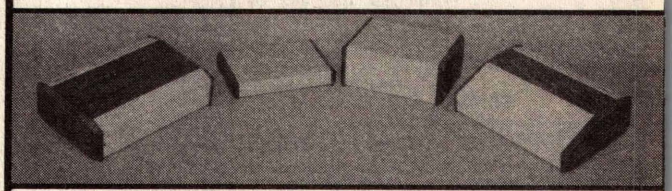

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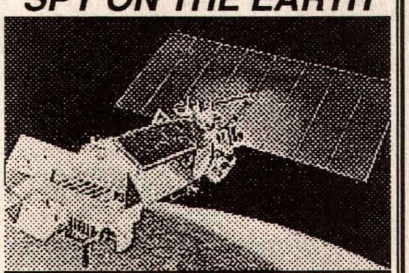

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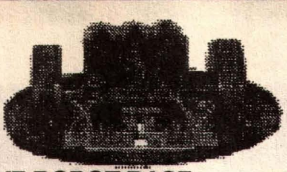

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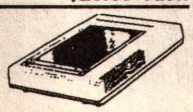

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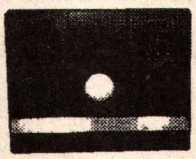

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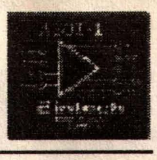

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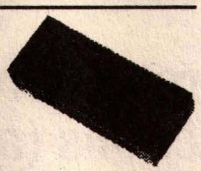

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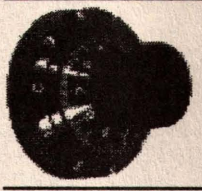

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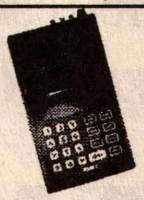

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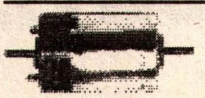

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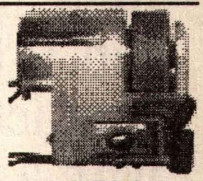

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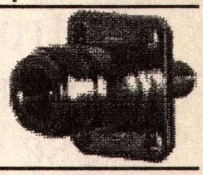

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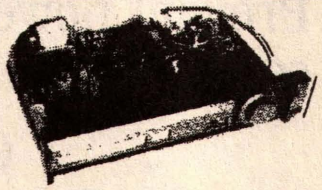

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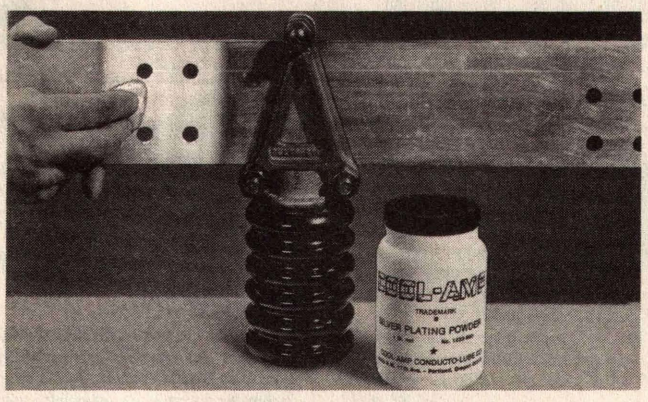

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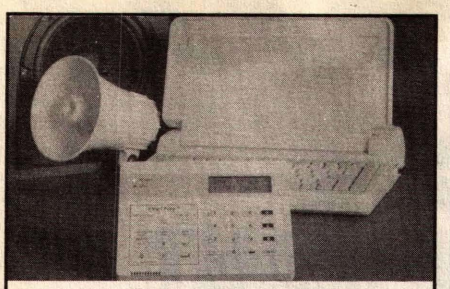

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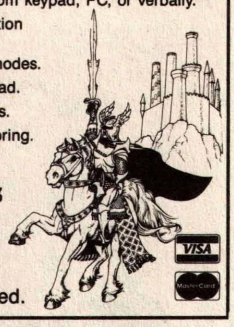

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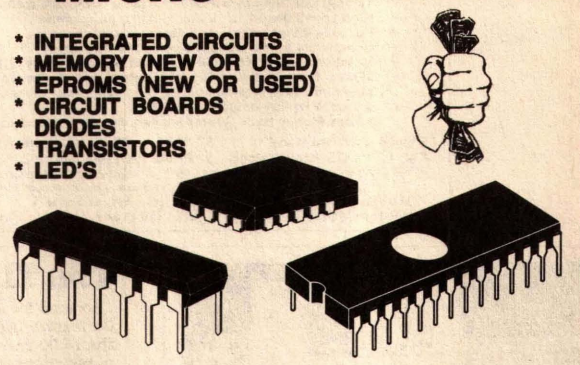
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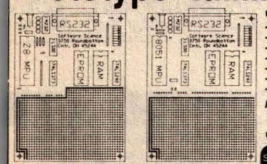
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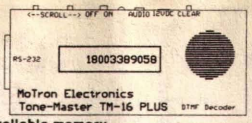

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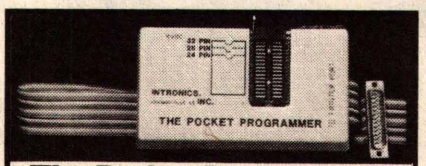

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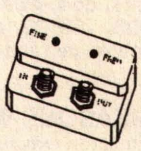

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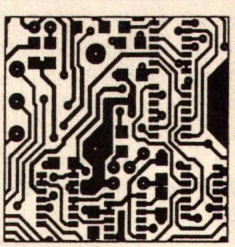

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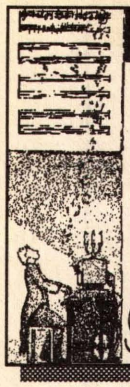

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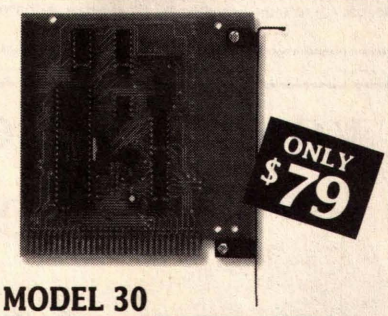

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By Staff Writer -

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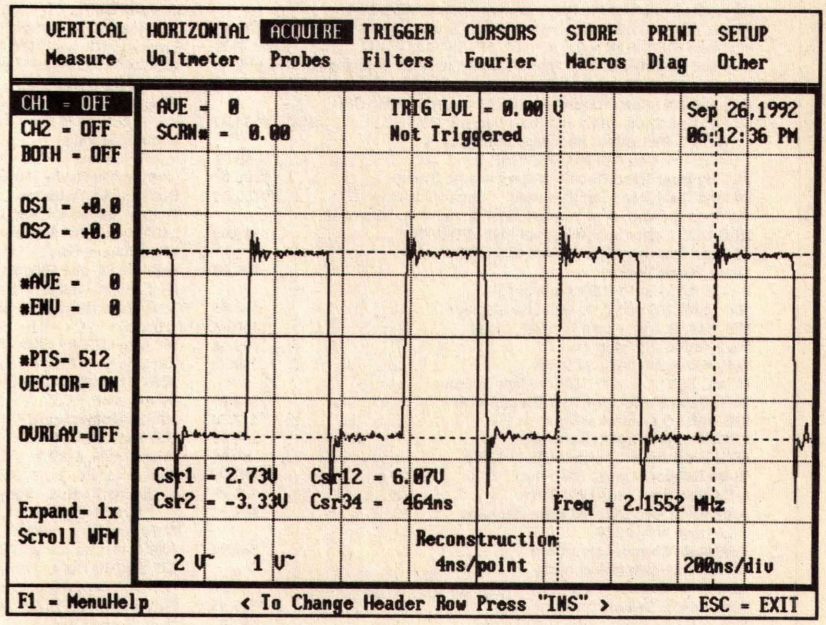

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MAXIMUM DIGITIZING RATE (Two-Channel Simultaneous)	40 Ms/sec	25 Ms/sec	25Ms/sec	25 Ms/sec
NUMBER OF CHANNELS	2 (+ 1 external trigger/enable)			
TIME BASE RANGE **	20ns-2 sec/div	50ns-2 sec/div	50ns-2 sec/div	50ns-2 sec/div
MAXIMUM TIME RESOLUTION	250 ps	400 ps	400 ps	1 ns
VERTICAL RESOLUTION	+/- 0.4% (8-Bit A/D)			
MEMORY (Standard)***	8K words	8K words	8K words	8K words

* = Available 4th Qtr 92
** = Screen display can zoom up to 10X
*** = 32K option available

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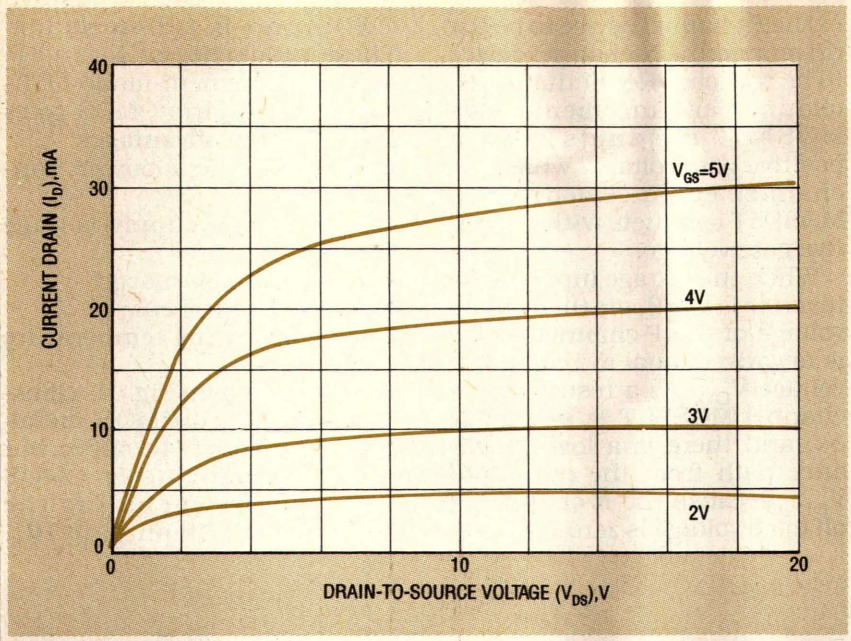


FIG. 10—DRAIN CURVES FOR AN N-CHANNEL, enhancement-mode MOSFET showing the effects of increasingly positive gate bias.

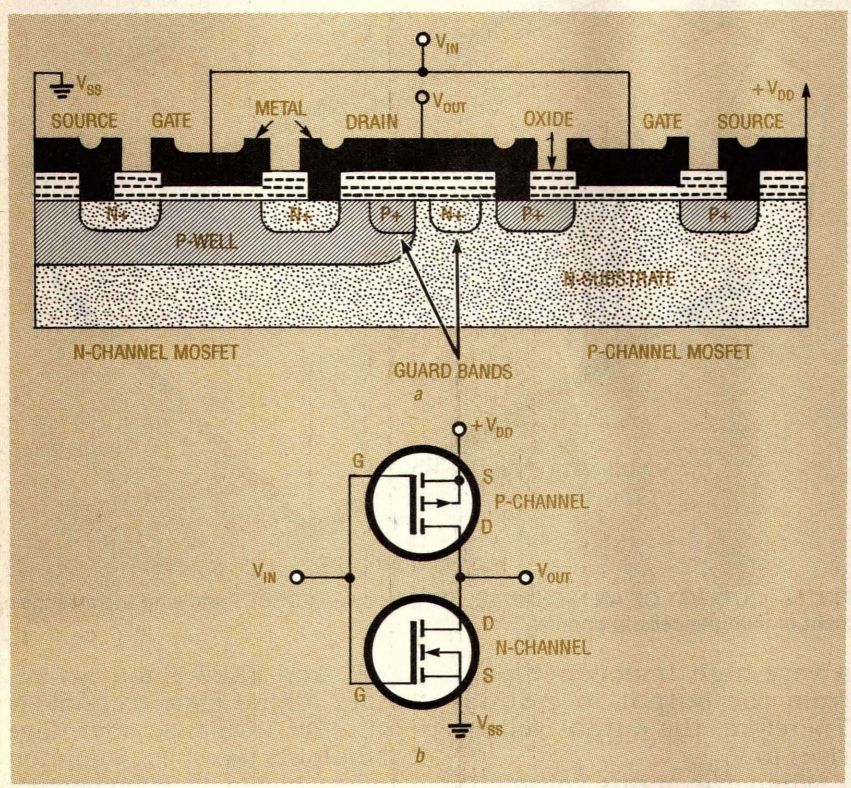


FIG. 11—CMOS INVERTER (NOT) GATE FORMED FROM N-CHANNEL AND P-channel enhancement-mode MOSFET's with power, ground, input, and output connections as shown in (*a*), and schematic (*b*).

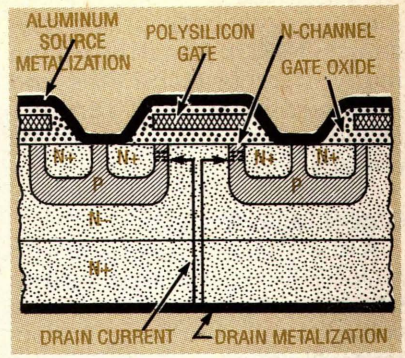


FIG. 12—SECTION VIEW OF AN N-channel DMOS power MOSFET showing its vertical structure and vertical current flow.

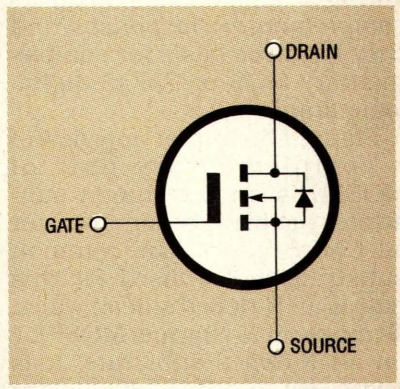


FIG. 13—SCHEMATIC SYMBOL FOR A DMOS power MOSFET including a drain-source diode.

electrons has accumulated, the P-type substrate material is converted into an N-channel, and drain-to-source conduction occurs. The magnitude of the drain current depends on the channel resistance, but it is controlled by the gate voltage.

The schematic symbol for an N-type enhancement-mode MOSFET is shown in Fig. 9-b. In this symbol, the gate does not make direct contact with the channel. The arrowhead points from the P-type substrate toward the (induced) N-type channel, shown as a line broken into three sections to indicate an intermittent channel.

Current flow in the channels of both kinds of enhancement-mode MOSFET's is proportional to the voltage on their gates, V_{GS}. This can be seen for an N-type enhancement-mode MOSFET by examining the family of gate voltage (V_{GS}) curves in Fig. 10. Current drain, I_D, is directly proportional to the positive value of gate voltage.

A P-channel enhancement-mode MOSFET is made the same way as the N-channel enhancement device except that P-type drain and source regions are diffused into an N-type substrate. The symbol for a P-type enhancement-mode MOSFET is the same as the one shown in Fig. 9-b except that the direction of the arrow is reversed. In the case of a P-type enhancement-mode MOSFET, the drain current is directly proportional to the negative values of its grid voltage.

The high gate impedance of all MOSFET's makes them susceptible to damage from even

low-energy electrostatic discharge (ESD). For this reason many discrete MOSFET's and IC's based on MOSFET's are protected with on-chip Zener diode circuits.

CMOS logic devices

An enhancement-mode MOSFET can act as a switch when it is turned on or off by a voltage applied to the gate electrode: N-channel MOSFET's are switched with positive gate voltage, and P-channel MOSFET's are switched with negative gate voltage. These are known as *complementary responses*, and they form the basis for complementary MOS or CMOS digital logic families.

Figure 11-a is a section view of a complementary pair of MOSFET's on a common substrate, the basic topography for all CMOS gates. The common substrate that is used for this pair is an N-doped silicon wafer. To make an N-channel MOSFET on an N-doped substrate, it is necessary to diffuse or implant a P-doped *well* in the substrate. The smaller N-type wells can then be formed in this P-doped region.

Because the substrate is N-doped, fewer steps are required to form the P-channel FET. The P- and N-doped guard bands isolate and insulate the individual transistors in this integrated circuit to prevent mutual interference. (Although not illustrated here, these guard bands are actually N- or P-doped rings formed around the complete FET below the oxide layer in this CMOS technology.

The two transistors in the section view, Fig. 11-a, can be connected to form a CMOS logic inverter, the simplest of digital logic circuits. This is accomplished by connecting the gates together to form an input (V_{IN}) terminal, and taking the output (V_{OUT}) from the common drain. The source on the left side of the diagram, V_{SS}, is grounded, while the source on the right side is connected to the positive supply, V_{DD}.

Those connections are shown schematically in Fig. 11-b. How does the inverter work? Consider the P-channel device to be the driver and the N-channel device to be the load. Recall that an N-channel enhancement-mode MOSFET conducts with a positive gate voltage, while a P-channel, enhancement-mode MOSFET conducts with a negative gate voltage.

When the voltage input to the inverter is low (logic 0), the gate voltage of the P-channel device is negative, equal to the supply voltage V_{DD}. As a result, the P-channel MOSFET is switched ON, and there is a low impedance path from the output to V_{DD}. Because the N-channel is off (gate voltage is zero), there is a very high impedance path from the output to ground. Therefore, the output voltage rises to V_{DD}.

When the input voltage is high (logic 1), the situation is reversed. The P-channel FET is cut off, and the N-channel FET is ON, so the output voltage falls to zero. Therefore, the circuit is a logic inverter: a *low* input results in a *high* output, and vice versa.

In either logic state one FET is ON while the other is OFF. Because one FET is always turned off, the quiescent current of the CMOS unit is extremely low. These properties of N- and P-type enhancement-mode FET's combined to form CMOS gates provide many advantages:

- Extremely low power consumption.
- Wide power supply voltage range.
- High DC noise margin
- High input impedance
- Wide operating temperature range.

The diagram in Fig. 11-a illustrates standard CMOS metal-gate technology (74C/4000), but there are many other CMOS technologies including the high-speed silicon-gate HC, HCT, and FACT families. Another digital logic technology called BiCMOS takes advantage of the lower power consumption and higher integration density of CMOS, and the higher speed and superior drive capability of bipolar transistors.

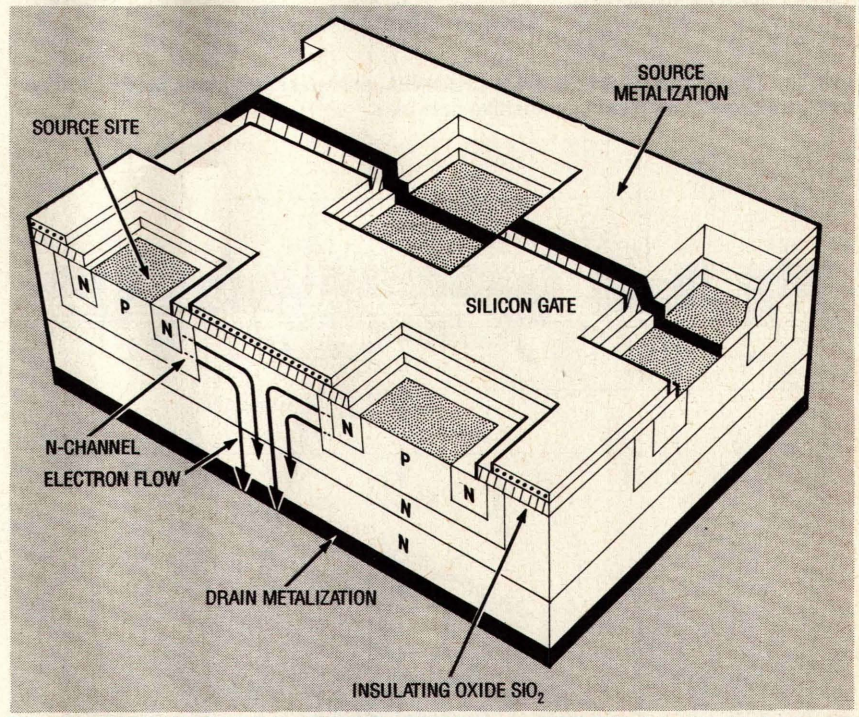


FIG. 14—CUTAWAY OF AN N-CHANNEL DMOS power MOSFET showing the arrangement of multiple cells in parallel.

Power MOSFET's

Power MOSFET's exhibit the properties of small-signal MOSFET's such as high-input impedance and voltage control, and they have drains, sources and gates, but they are designed

continued on page 89

Learn more about capacitors—how they are made, and how you can apply them more cost-effectively in your circuits

CAPACITORS

RAY MARSTON

CAPACITORS RANK NEXT TO RESISTORS as the most widely purchased electronic components. Fixed and variable capacitors for electronics available from commercial sources have capacitance values from a few picofarads (pF) to farads (F). And these components are made from an amazingly wide variety of materials.

The outstanding trend in capacitor design and manufacture over the past 85 years—particularly since the arrival of the integrated circuit—has been miniaturization. The objective of all efforts has been to cram as much capacitance as possible into ever smaller packages, while at the same time increasing their reliability.

To gain a better understanding of this trend, and to appreciate what has been accomplished, it is worth reviewing the fundamental capacitor formulas. The ability of a capacitor to store electric energy is a function of its geometry and the physical characteristics of its dielectric.

The amount of energy that a capacitor can store is given by the equation:

$Q = CE$

where Q = the magnitude of the stored charge in coulombs
C = capacitance in farads
V = applied voltage in volts

Figure 1-*a* shows the simplest capacitor and identifies its principal parts and physical variables; Fig. 1-*b* is the accepted schematic symbol in North America for a fixed capacitor, and Fig. 1-*c* is the accepted symbol for a variable capacitor.

Capacitance in farads is determined by:

$C = kA/d$

where k is the dielectric constant (permitivity), the ratio of the ability of a dielectric material to store electrostatic energy to that stored by a vacuum between the same electrodes (see Table 1).

A = directly opposing plate area
d = distance between the plates

Different multiplying factors can be applied to this equation so that the value for C is in microfarads or picofarads when A and d are measured either in inches or millimeters. Nevertheless, important engineering tradeoffs can be seen from both of these equations:

- To store a given charge, more voltage is needed for a small capacitor than a large one.
- If the opposing plate area, A, is held constant, the value of capacitance can be increased by:

a. Decreasing the thickness of the dielectric, h.
b. Using a dielectric with a higher constant, k.
c. Doing both (a) and (b) simultaneously.

While not apparent from the formulas, other facts about capacitors to be considered are:

- The maximum voltage that can be impressed across a capacitor, without destroying it, depends on the dielectric and the separation of the plates.
- For a given dielectric, the allowable maximum voltage can be increased as the distance be-

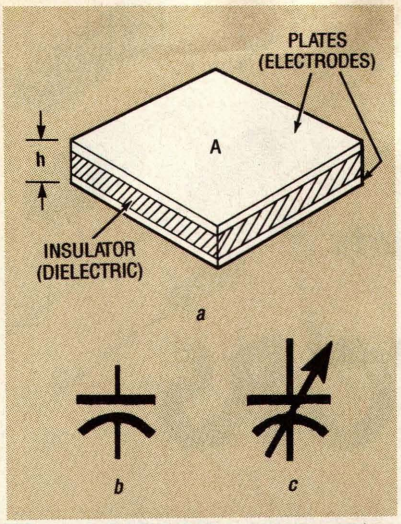


FIG. 1—A BASIC PARALLEL-PLATE capacitor has parallel metal plates or electrodes separated by a dielectric that can be air or a solid insulator.

tween the plates is increased.

The volumetric efficiency of capacitors has been improved within the constraints mentioned. How this has been done will be explained in the discussion of each of the most common capacitor manufacturing technologies.

Advanced circuit manufacturing methods have increased demand for miniature chip capacitors for hybrid circuits and surface mounting. New plastic film and ceramic dielectrics now offer a wider range of operating characteristics than was available ten years ago; metalizing has reduced capacitor weight and size by eliminating metal foil from many film capacitors now being produced.

The quality and reliability of electrolytic capacitors has been improved with more effective methods for etching foils, the introduction of better electrolytes, and improved sealing. Solid-electrolyte tantalum capacitors made as dipped radial or chip units are becoming more popular. Capacitors made from mica and glass have faded away to become specialty items, with their former functions largely performed by multilayer ceramic capacitors. Moreover, ceramic disk caps are rarely specified in new designs; they have been replaced by smaller, easier-to-place ceramic tubular capacitors.

The fabrication of increasing numbers of capacitors within very large scale integrated circuits such as microprocessors and digital signal processors has not reduced sales of discrete capacitors; in fact, the sales of certain kinds of capacitors have increased because of the proliferation of IC's. Moreover, capacitors are necessary in the external circuitry for the dedication of such multifunction linear IC's as compandor and modulation chips. Thin- and thick-film capacitors are being formed on ceramic substrates for networks and hybrid circuits that operate well into the microwave band.

Variable capacitors, still used primarily in radio-frequency circuits, are also being made from improved plastics and ceramics, a departure from their traditional dielectrics of air, glass, and ceramic, to reduce their size, extend their capacitance range, and cut cost.

Capacitor terms

Capacitors are widely specified with a glossary of widely accepted technical terms. A knowledge of these terms will be helpful to anyone who specifies or uses capacitors.

Capacitance. The basic unit for capacitance is the farad, but most capacitors for electronics applications need capacitance values that are only small fractions of a farad: microfarad (μF—one-millionth of a farad) and picofarad (pF—one-millionth of one-millionth of a farad).

Ambient temperature. The actual value of a capacitor depends on the temperature of its environment, known as *ambient* temperature. *Percent capacitance change*, a function of temperature, is referred to room temperature, 25°C.

Capacitive tolerance is the variation in capacitance value of the capacitor expressed as a percentage of its value at room temperature, 25°C, which is referred to as the *nominal value.*

Temperature coefficient (TC) is the change in a capacitor's capacitance per degree change in temperature, expressed in parts per million per degree Celsius (ppm/°C). The coefficient can be positive, negative, or zero. The letter P indicates that the coefficient is positive: N if negative. The designation NPO identifies a zero-temperature coefficient.

Rated working voltage is the maximum permissible operating voltage at which a capacitor can be continuously operated at maximum rated voltage (without derating). This rating must be specified as AC or DC because they are not usually equal.

Surge voltage is the maximum instantaneous voltage to which the capacitor should be subjected; exceeding that voltage will cause the capacitor's breakdown. Surge voltage is higher than working voltage.

DC leakage is the small amount of direct current that flows in a capacitor at a specified voltage. Caused by the presence of free charge carriers within the dielectric, it is the reason why a charge cannot be stored indefinitely in a capacitor; eventually it leaks off.

Insulation resistance (IR) is the resistance of the dielectric. High resistance results in low leakage current. This variable is inversely related to ambient temperature.

Capacitive reactance (X_C) of a capacitor is inversely related to the product of capacitance and frequency in accordance with:

$X_C = 0.159/f \times C$

where 0.159 is a conversion constant

X_C = capacitave reactance (ohms)

f = frequency (hertz)

C = capacitance (farads)

TABLE 1
DIELECTRIC CONSTANTS COMMON CAPACITOR MATERIALS

Dielectric	*k*
Vacuum	1
Air	1.0006
Polystyrene	2.5
Polyester	3
Mica	5
Aluminum oxide	7
Tantalum oxide	25
Ceramic (low *k*)	10
Ceramic (high *k*)	100—10,000

Power factor (PF) expresses the ratio of energy dissipated to the energy stored in a capacitor, as a percent. It typically exhibits a negative slope below room temperature and positive slope above it.

Equivalent series resistance (ESR), expressed in ohms, is the sum of all internal resistance values of a capacitor. These include lead resistance, terminal losses, and dissipation in the dielectric. ESR increases with frequency.

Impedance (Z) of a capacitor is the total opposition it offers to the flow of alternating current at a given frequency:

$$Z = \sqrt{X_C^2 + (ESR)^2}$$

where Z = impedance (ohms)
X_C^2 = capacitive reactance (ohms)
ESR = equivalent series resistance (ohms)

Capacitive impedance is inversely proportional to frequency and temperature; ideally, it equals capacitive reactance.

Dissipation factor (DF) of a capacitor is the ratio of energy dissipated to energy stored in the dielectric. DF is a figure of merit for the quality of a capacitor.

$$DF = ESR/X_C \times 100\%$$

Ideally capacitors have low values of DF over wide temperature ranges.

Q or *Quality factor* is the ratio of energy dissipated to energy stored, so it is the reciprocal of dissipation factor at low frequencies.

$$Q = 1/DF = X_C/ESR$$

The highest quality capacitors have high Q's.

Ripple current is the result of a periodic AC voltage wave superimposed on the DC voltage applied to the capacitor. Ripple current flowing through the ESR of a capacitor can generate heat, raising the temperature of the capacitor.

Volumetric efficiency is a measure of relative capacitance per unit volume. One capacitor has a higher volumetric efficiency than another capacitor of the same size (volumetric dimensions) if it is able to store more charge, or has a higher capacitance rating.

Capacitor applications

Capacitors have many different applications in electronic circuits:

- *Blocking*—limiting the flow of direct current or low frequency alternating current without significantly affecting the flow of high-frequency AC.
- *Bypassing*—providing a low-impedance path around a circuit component to permit the flow of alternating current
- *Coupling/decoupling*—coupling or decoupling alternating signals between circuits and systems.
- *Energy storage*—storing electric energy for later release to power a device or circuit.
- *Filtering*—removing the DC component from a signal.
- *Smoothing*—reducing the ripple on an input signal
- *Timing*—providing capacitance value in timing circuits.
- *Tuning*—providing capacitance value for tuning in a tank circuit.

Fixed capacitors

Figure 2 is a diagram showing how fixed capacitors are classified as *electrostatic* and *electrolytic*. Electrostatic capacitors are so named because an electrostatic charge is stored between opposing plates. They are named for the dielectrics between their plates. This can be air or a vacuum or such solid materials as plastic film, ceramic, mica, and glass.

Electrostatic capacitors are further classified by packaging method: leaded or non-leaded (chip); radial or axial leaded; molded, conformally coated, or dipped in an encapsulant, typically epoxy. A film capacitor can be further classified by the specification of its plastic film such as polyester or polycarbonate.

Electrolytic capacitors are made of metals, normally either aluminum or tantalum, that form extremely thin anodic oxide layers of high-dielectric constant and good electrical characteristics during electrolytic processing. These capacitors are classified by the metal from which their anodes are made—aluminum or tantalum—and capacitor configuration: wet foil, wet slug, or dry slug (solid electrolyte).

Film capacitors

Film capacitors are made with thin dielectric plastic films such as polyester (Mylar), polycarbonate, polystyrene and polypropylene that is 0.06 mil (1.5 micrometers) to over 0.8 mil (20 micrometers) thick. The electrodes of film capacitors can be metal foil (film/foil) or metal directly deposited on the film (metalized). Film/foil capacitors are made of dielectric film sandwiched between tin or alumi-

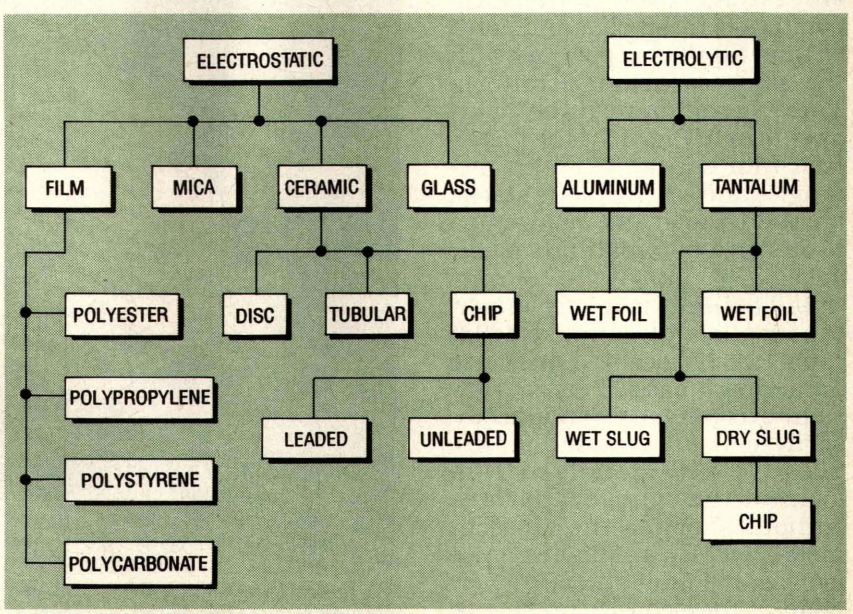


FIG. 2—POPULAR FIXED CAPACITORS are organized as electrostatic and electrolytic, and identified by their dielectric and package style.

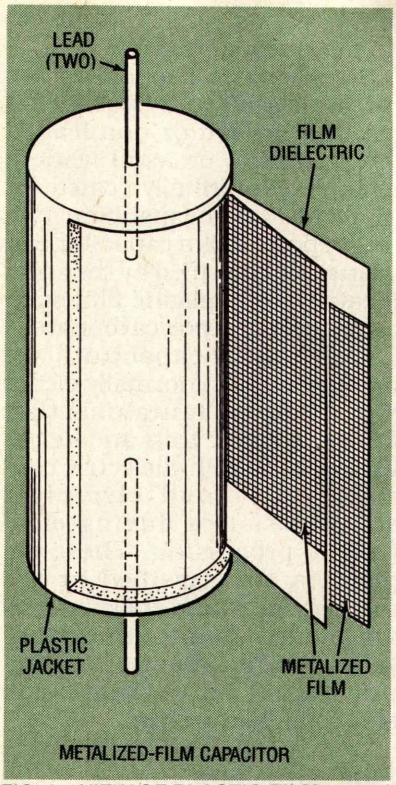


FIG. 3—VIEW OF PLASTIC-FILM capacitor shows how metalized-film dielectric (with leads connected) is rolled into a cylinder and jacketed with molded or conformally coated plastic.

num foil plates (about 0.25-mil thick). They are most widely specified for energy storage, pulse discharge, and arc suppression applications.

The plates of metalized capacitors are very thin vacuum-deposited layers of aluminum or zinc, which permits these capacitors to be smaller and lighter than film/foil capacitors with the same capacitance ratings. These capacitors can be made as shown in Fig. 3, or the metalized film can be cut into rectangles and stacked. The stacks are then leaded and molded in a protective encapsulant package.

Self-healing is a very important feature of metalized-film capacitors. A localized dielectric breakdown caused by a transient overvoltage will not necessarily cause capacitor failure because the metalized film around the fault evaporates without shorting the adjacent metalized plates. This response isolates the fault and effectively restores the electrical properties of the capacitor.

Both film/foil and metalized-film capacitors are made with axial or radial leads in a variety of case sizes. They can be hermetically sealed in tubular or rectangular metal cases, or encapsulated by molding or conformally coating with epoxy.

Film capacitors are most widely specified for capacitance values from 500 picofarads to 10 microfarads. (Refer to Table 2.) Their working voltages typically range from 50 volts DC to 630 volts DC—although they can have higher ratings. Capacitance tolerance is typically from ±1% to ±10%

Film dielectrics

The four most widely used film dielectrics are:

- *Polyester* (tradenamed Mylar) capacitors are the most popular general-purpose film capacitors. This film permits high volumetric efficiency, low leakage, and a moderate temperature coefficient. Some film/foil and metalized units can operate to 125°C at 50% of rated voltage. Metalized- polyester units can perform blocking, coupling, decoupling, bypass, and filtering.
- *Polycarbonate* capacitors have operating temperatures from -55°C to as high as +125°C with proper voltage derating. Capacitive tolererances can be as low as ±5%. This dielectric film offers high insulation resistance and stability.
- *Polystyrene* capacitors have characteristics that are similar to those of polypropylene, but they have lower volumetric efficiency. They have capacitive tolerances as low as 1%. Film/foil units are widely used in inductive-capacitive filters.
- *Polypropylene* capacitors have higher volumetric efficiency than polyester capacitors. Except for AC rating, their characteristics are similar to those made from polystyrene. They have tolerances as low as ±2%. These capacitors are specified where precision, reliability, and low losses are important: e.g. tuning, filtering, and timing.

Ceramic capacitors

There are three ceramic capacitor styles: single-layer disc, single-layer tubular, and monolithic multilayer. There are three principal classes of ceramic dielectric based on their *k* rating: Class I, II, and III. Low-*k* materials have linear characteristics, and their properties are independent of frequency over their normal range. They are suitable for resonant-circuit or filter

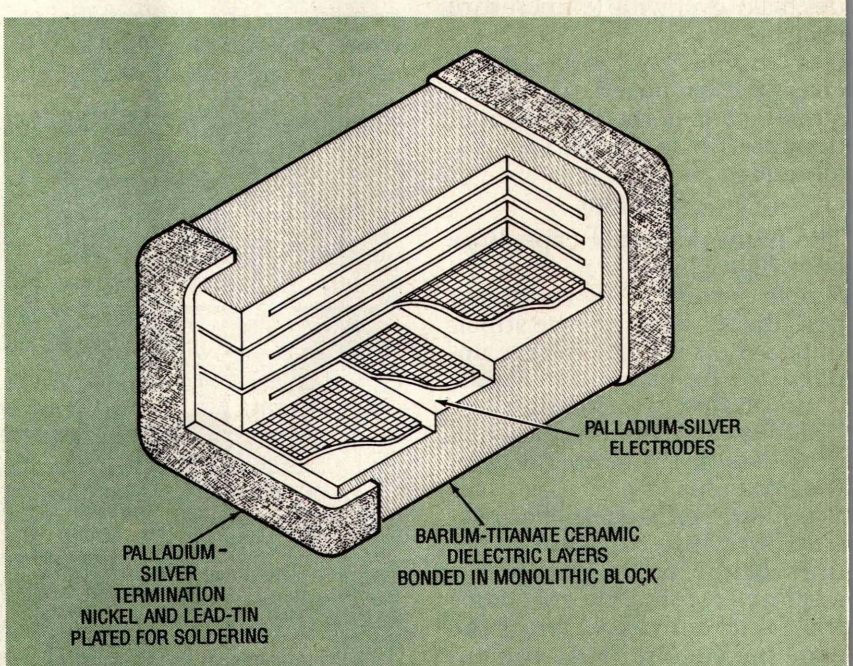


FIG. 4—CUTAWAY VIEW OF A CERAMIC MULTILAYER CHIP capacitor shows noble-metal electrodes deposited on thin layers of ceramic dielectric which are then pressed and fired to form a monolithic unit.

characteristics. High-*K* ceramics have very high effective dielectric constants. They are suitable for coupling and decoupling applications.

- *Disc ceramic* capacitors are made by metalizing both surfaces of a thin low-*k* (Class III) ceramic disc with silver-based ink to form the electrodes, firing the disk, and soldering on radial leads. They are jacketed by dipping in phenolic resin or epoxy. These capacitors are being replaced by tubular ceramic units made of the same materials that save circuit board space and permit automatic parts placement.
- *Tubular ceramic* capacitors are made by coating the inner and outer surfaces of Class III ceramic tubes with silver-based thin-film ink, firing, and attaching leads to the tube before jacketing it by epoxy dipping.
- *Monolithic multilayer ceramic* (MLC) capacitors are made by screening thin-film, precious metal-based conductive ink on thin layers of "green" or unfired layers of higher *k* (Class II and III) ceramics. The screened layers are then stacked (up to 40 layers), compressed, and fired to form monolithic capacitors, as shown in Fig. 4.

If the MLC capacitor is to be a chip capacitor for a hybrid circuit or surface-mounting, conductive-metal terminations are plated on its ends, as shown in Fig. 4. The terminals of surface-mount chips are further plated with lead-tin alloy to improve the terminal-to-pad solder joints.

Demand for MLC chips has risen with the worldwide growth of surface mounting. Chip MLC's will withstand the molten- solder temperatures encountered in reflow and wave soldering. They are available in standard sizes to fit the grasping tools in automated pick and place machines. The most common sizes are 0.08 ×0.05 inch (0805), 0.125 × 0.063 inch (1206), and 0.05 ×0.225 inch (2225).

Cylindrical leadless capacitors are also made for surface mounting. These capacitors

TABLE 2
CHARACTERISTICS OF POPULAR FIXED CAPACITORS

Type	Capacitance Range	Working Voltage	Maximum Operating Temp. (C)	Tolerance (Percent)
Electrostatic				
Film				
Polyester (Mylar)				
Film/foil	0.001—1.0	80—200 VDC	+125*	±5—±10
Metalized	0.001—10.0	60—630 VDC	+125*	±5—±10
Polycarbonate				
Metalized	0.01—10	100—630 VDC	+125*	±5—±10
Polystyrene				
Film/foil	47 pF—0.039	63—630 VDC	+85	±1—±5
Polypropylene				
Film/foil	47 pF—0.022	63—630 VDC	+85	±2—±5
Metalized	0.001—3.3	250—100 VDC	+85	±5—±10
Ceramic				
Multilayer	10 pF—.56	200 VDC	+125	±5—±10
Disc	.75 pF—2.2	50—6 KVDC	+125	±5—±10
Mica	1 pF—0.1	50,000	+150	±.25—±5
Glass	10 pF—0.15	6000	+125	±1—±20
Electrolytic				
Aluminum	1.0—1 MEG	5—450	+105	−10—+100
Tantalum				
Wet slug	1.7—2400	6—630	+125	±5—±20
Wet foil	.12—3500	3−300	+125	±5—±20
Solid slug	0.0023—1000	6—100	+125	+5—±20

* With derating

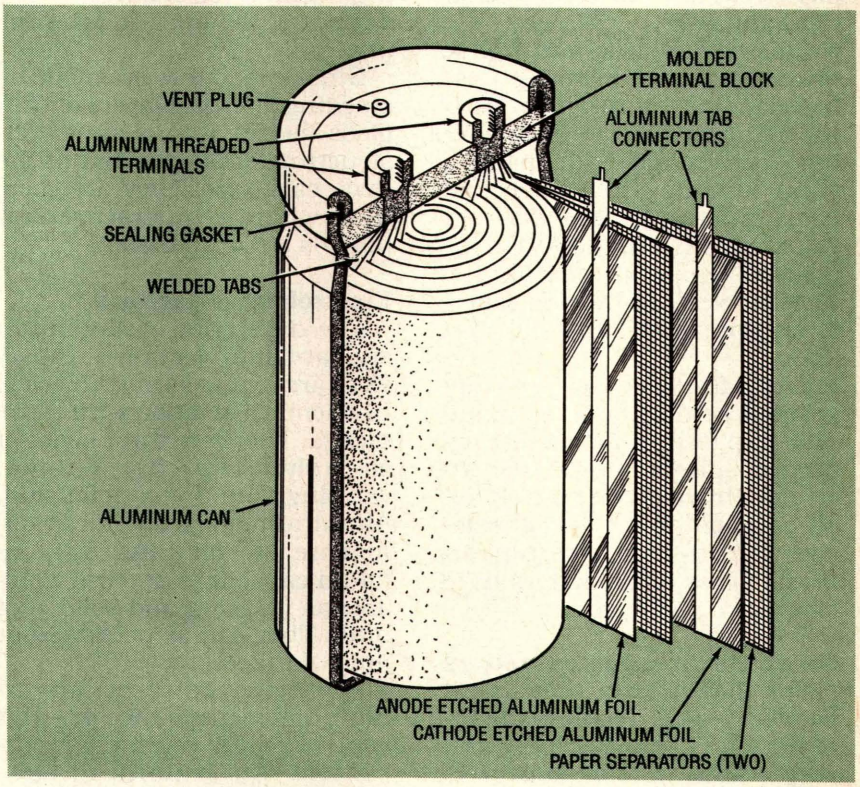


FIG. 5—VIEW OF AN ALUMINUM ELECTROLYTIC CAPACITOR shows how the cathode (porous paper spacer filled with liquid electrolyte) is sandwiched between the oxidized aluminum anode foil and cathode connection foil, rolled into cylinder,and then sealed in an aluminum can.

have metalized-band contacts on the ends of their epoxy-coated bodies for soldering to lands of surface-mount circuit boards.

For conventional through-hole mounting, axial or radial leads are attached, and the chip is jacketed by dipping or molding in epoxy. MLC capacitors are specified for bypassing noise to ground, timing, and frequency selection.

Ceramic dielectrics

Ceramic dielectric materials are classified by dielectric constant *k* as Class I, Class II and Class III:

- *Class I* dielectrics are made by mixing magnesium titanate (for a positive temperature coefficient) with calcium titanate (for a negative coefficient) to form a dielectric material with low *k* values, and properties essentially independent of frequency. They exhibit ultrastable temperature coefficients of ±30 ppm/°C over the temperature range of -55° to +125°C. Class I includes NPO (negative, positive, zero), also known as COG and BY.
- *Class II* dielectrics are high-*k* materials (called ferroelectrics) based on barium titanate. With the addition of barium stanate, barium zirconate, or magnesium titanate, their dielectric constants can be lowered from values as high as 8000 for increased temperature stability. These dielectrics include general purpose X7R (BX) and Z5U (BZ).
- *Class III* dielectrics were developed primarily for ceramic disc capacitors because they permit high volumetric efficiency. But this introduces a trade-off between high leakage resistance and low dissipation factor. Class III capacitors have low working voltages.

Other electrostatic capacitors

The dielectric in a *mica* capacitor is mica, a natural mineral that is chemically inert and very stable. The capacitor is generally made as a "sandwich" of alternating layers of tin-lead foil plates and mica. These capacitors can operate at temperature up to +150°C. Silvered mica capacitors offer greater mechanical stability and more uniform characteristics. They are made by screening and firing a thin layer of silver on the surface of the mica to form the plates.

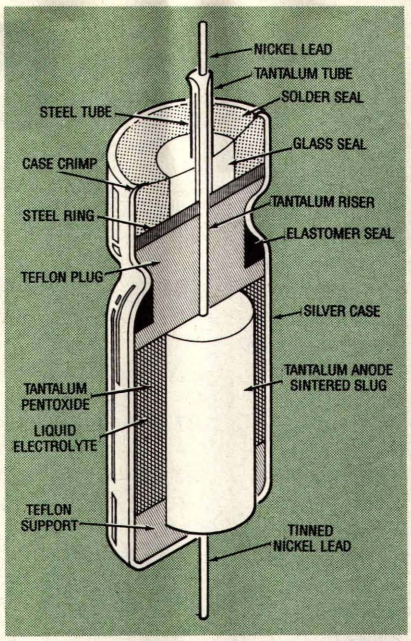


FIG. 6—CUTAWAY VIEW OF WET-SLUG tantalum capacitor shows tantalum slug filled with wet-electrolyte sealed in a silver case.

Glass capacitors are made by stacking alternate layers of thin glass dielectric in a sandwich structure similar to that of the mica capacitor. They are specified where temperature stability is a requirement.

Electrolytic capacitors

The dielectrics of aluminum and tantalum electrolytic capacitors are oxides formed by electrochemical reaction with those metals. There are three styles of electrolytic capacitor: wet foil, wet slug, and dry or solid slug. Aluminum electrolytic capacitors are wet foil units, but tantalum capacitors are also available as wet-slug and solid slug units. They can be *polarized* or *nonpolarized.*

All electrolytic capacitors exhibit high capacitance per unit volume (high volumetric efficiency). An aluminum electrolytic capacitor can store four, five or more times the charge of an equivalent-size film capacitor, and a tantalum capacitor can store three times as much charge as an equivalent aluminum capacitor.

However, aluminum electrolytic capacitors have higher DC leakage and lower insulation resistance than electrostatic capacitors. Moreover, they have higher power losses because of their higher equivalent series resistance (ESR).

The anodes of aluminum electrolytic capacitors are made from high-purity aluminum foil that has been electrochemically etched to increase its effective surface area. A thin aluminum-oxide-dielectric layer, about 0.01 micron, is then grown on the etched foil in another electrochemical process. The enlarged surface area of the etched foil provides a far larger dielectric surface than would be possible with unetched foil.

A porous paper spacer filled with a liquid electrolyte is sandwiched between the etched and oxidized anode foil and another aluminum cathode foil. The liquid electrolyte is the actual cathode, but the cathode foil is in contact with the liquid electrolyte and is needed to complete the electrical circuit.

After attaching a series of connecting tabs to the foils, the "sandwich" is rolled, as shown in Fig. 5, and inserted in an alu-

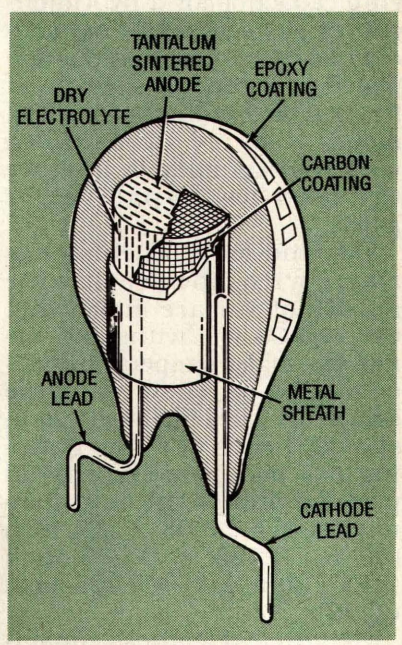


FIG. 7—CUTAWAY VIEW OF A SOLID tantalum capacitor jacketed by dipping in epoxy.

minum can, which is then sealed. However, the sealed can has an overpressure vent.

Direct current must flow in only one direction in a polarized electrolytic capacitor. Even short-term current reversal could destroy the oxide dielectric and short-circuit the capacitor. A "+" mark on the case identifies its positive terminal.

Aluminum electrolytic capacitors are made with radial or axial leads, and some styles for switchmode power supplies have spring-metal terminals that snap into circuit board holes. An external plastic sleeve permits off-ground applications for the capacitor.

Nonpolarized aluminum electrolytic caps are essentially two polarized capacitors back-to-back with their cathode terminals connected. The anode terminals make the external circuit connection, while the cathode terminals are isolated by an insulator. Both foils are anodized to form oxide barriers, and they share a common electrolyte-filled porous spacer.

A nonpolarized capacitor has half the capacitance of a comparably sized polarized capacitor with the same voltage rating. Although not as efficient as polarized capacitors, the nonpolarized units are used for AC motor starting and other AC control applications.

Tantalum capacitors

Tantalum electrolytic capacitors are available in three forms: wet-foil, wet slug, and dry slug. Wet-foil tantalum capacitors are made in about the same way as aluminum electolytics. As a group, tantalum capacitors exhibit higher volumetric efficiency, more stable characteristics, higher operating temperature ranges, and longer shelf lives than aluminum capacitors. However, they cost more and have lower voltage ratings.

Both wet and dry slug tantalums are made from porous pellets of tantalum. The anode slug is formed by pressing tantalum powder and a binder in a mold, and firing it in a vacuum furnace (*sintering*) to bond the powder and drive off the binder.

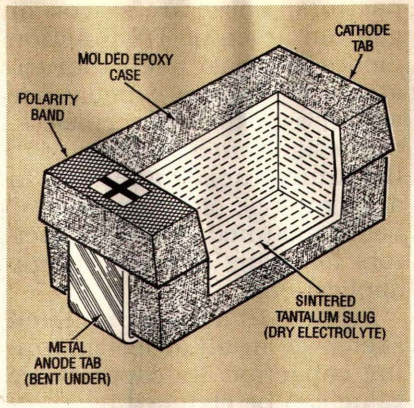


FIG. 8—CUTAWAY VIEW OF A SOLID tantalum capacitor chip for surface mounting applications.

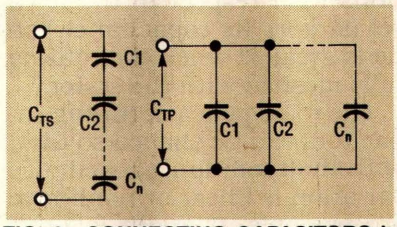


FIG. 9—CONNECTING CAPACITORS in series yields a total capacitance that is less than that of the lowest-value unit (*a*), but connecting them in parallel yields a total capacitance equal to the sum of all unit values.

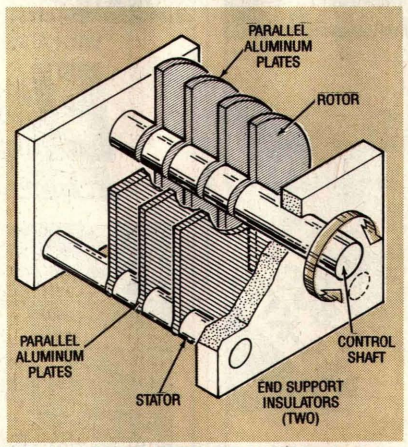


FIG. 10—SIMPLIFIED DRAWING of a tuning capacitor shows a concept that is used in many variable capacitors.

The tantalum oxide dielectric is electrochemically formed in the porous pellet.

Figure 6 is a cutaway view of a wet-slug tantalum capacitor with an acid electrolyte. Its volumetric efficiency about three times that of a comparably sized foil unit. Moreover, wet-foil tantalums are the most reliable of all capacitors.

The high cost of wet-foil and wet-slug tantalums makes them too expensive for most consumer and industrial applications. However, those high-reliability capacitors are widely specified for military electronics and avionics. Military specifications MIL-C-3965 and MIL-C-39006 govern the procurement of military-style wet-foil and solid-slug units.

The solid-anode or dry-slug unit, shown in Fig. 7, is the most popular and economical tantalum capacitor. It has a thin film of manganese dioxide chemically deposited on its tantalum dioxide dielectric to act as a second electrode. Solid-slug capacitors can be sealed in metal cases, or protected by dipping in epoxy as shown in Fig. 7. The solid-slug units have the longest life and lowest leakage of any tantalum caps. Chip capacitors for surface mounting, as shown in Fig. 8, are made by the same process.

Capacitor identification.

Today the capacitor's nominal value (and sometimes its tolerance) are printed on its body where space permits. Values such as 47 and 68 are typically in microfarads, while values such as 120 or 4700 are usually in picofarads. A capacitor might also be marked with its working voltage: for example, 63 V or 100 V.

Some capacitors are still marked with colored bands based on the EIA system used for identifying resistors. The colors of the bands are read from left to right. A black band represents zero, brown represents one, and red, orange, yellow, green, blue, and violet represent the digits two to seven, in that order. Grey represents eight, and white represents nine. As in resistor coding, a gold band denotes a capacitive tolerance of 5%, while a silver band denotes 10%

You might encounter capacitors with obsolete coding schemes in old radios or TV's or at surplus sales. Some of those codes are based on colored dots, spots or "hashmarks." It is wise to consult a radio engineering handbook or data reference book published before 1970 if

you want to find out how to interpret those codes if you plan to use them in your circuits and are in doubt about their ratings.

Connecting capactors

Figure 9 illustrates capacitors connected in series and parallel. The formula for calculating the effective value of two capacitors in series is:

$C_{TS} = C1 \times C2/C1 + C2$

For two or more capacitors in series it is:

$C_{TS} = 1/1/C1 + 1/C2 + 1/C3 + 1/C_n$

For capacitors in parallel the formula is:

$X_{TP} = C1 + C2 + C3 + C_n$

Variable capacitors

For many years the most prominent variable capacitors were those used to tune radio receivers, transmitters, and oscillators. However, in the latest transistorized equipment they have been largely superseded by *varactors* or voltage variable capacitors. These are silicon or gallium arsenide PN junction diodes that make use of the variation of junction capacitance with reverse bias. Nevertheless, the design concept embodied in the tuning capacitor lives on in a wide range of miniature, PC board-mounted variable capacitors for many different tuning applications.

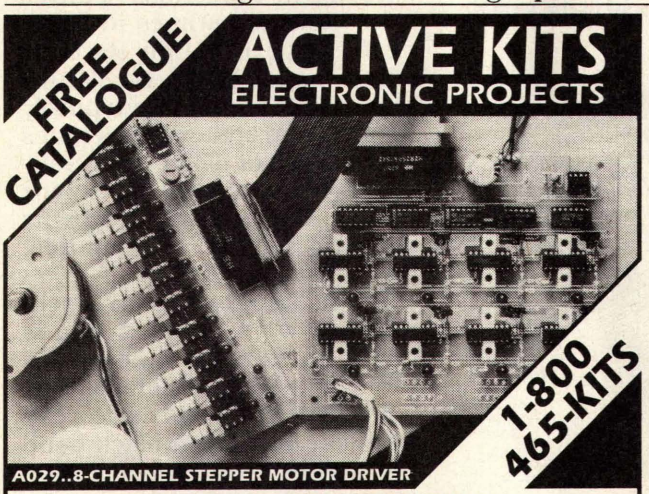
Figure 10 is a simplified sketch of an air-dielectric tuning capacitor. Its capacitance value can be changed by rotating its control shaft so that the movable set of metal plates (*rotor*) meshes in different positions with respect to the fixed set (*stator*). Its capacitance value is greatest when the rotor is fully meshed with the stator.

The rotor plates of tuning capacitors can be shaped so that, with shaft rotation, capacitance variation is linear or nonlinear. For example, it might follow a nonlinear logarithmic or square law function. Two or more tuning capacitors can be ganged together so that they vary in unison, simultaneously tuning separate circuits to different frequencies.

Trimmer capacitors are "set and forget" variable capacitors made for infrequent adjustment. Many different types are available for commercial and industrial applications. *Vane* types are miniaturized versions of the tuning capacitor shown in Fig. 10, except that layers of solid dielectric, typically plastic, are inserted between the rotor and stator plates.

Vane-type trimmers with body diameters of less than a half inch are made for PC-board mounting. They have plastic cases and dielectrics of polypropylene, polyethylene, polycarbonate, or PTFE films. These trimmers are made for screwdriver and/or key adjustment.

There are also simpler trimmer capacitors that permit more limited capacitance variation for high-frequency tuning applications. Ω



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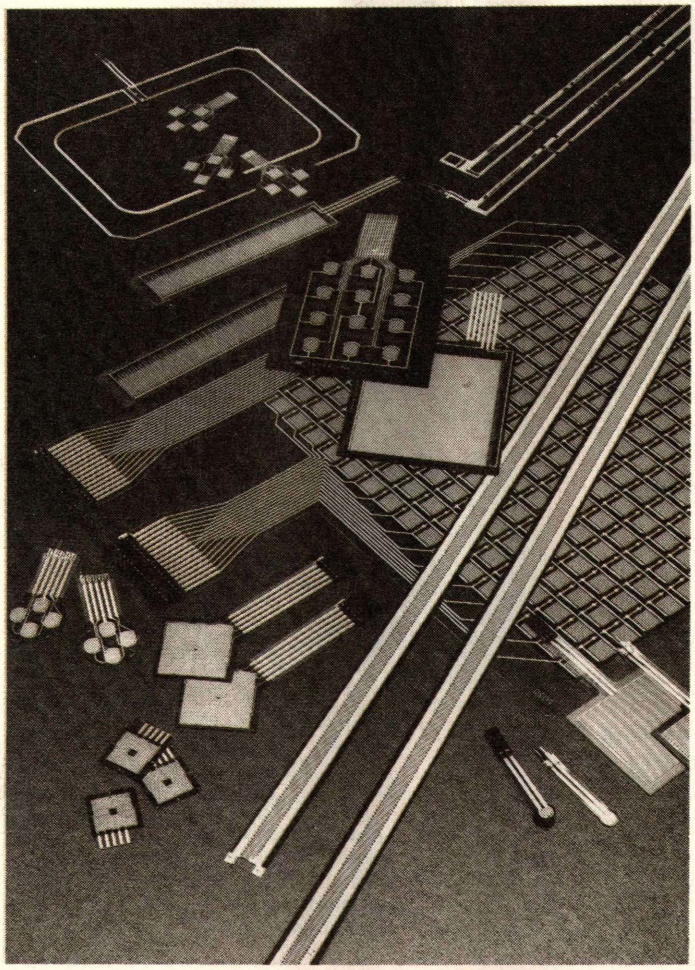
FORCE-SENSING RESISTORS



Force-sensing resistors open up lots of new applications for electronics.

T.L. PETRUZZELLIS

NE OF THE MANY
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ant, and they are
nsensitive to vibra-
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erence. FSR's con-
ain no moving
arts to wear out,
nd can withstand
ver ten million operations. Fig-
re 1 shows some of the dif-
erent types of FSR's.

FSR's are as thin as business
ards, and can be designed to
ense forces as light as a finger-
ip or as heavy as a truck. They
an also sense variations in ap-
lied pressure and alter their re-
ponse accordingly. In addition,
he sensor's actuation thresh-
ld can be adjusted using sim-
le electronics. Applications for
SR's are virtually unlimited, as
ou can see from Table 1. The
SR is ideally suited to keypads,
omputer input devices, touch
witches, alarm sensors, limit
witches, electronic keyboards,
igitizers, and pressure sen-
sors.

An FSR device typically ex-
hibits three decades of dynamic
resistance change with respect
to force and it can operate at
much lower currents than most
other sensors. The FSR can also be used to construct a linear potentiometer which can monitor the *position* of a force as well as the *amount* of applied force. A three-layer XYZ-type FSR device can be constructed that will give an X-Y coordinate position indication with a 0.005-inch resolution, as well as provide the force (Z) measurement. The XYZ pad is ideal for such applications as a graphic pad, pen stylus tablet, or mouse-type device for computer input. The FSR sensors can also be configured into many different types of switch arrays, with sizes up to 22 × 32 inches, at much lower cost than many other force sensors.

In the past, there were two principle types of force sensors: piezopolymers and ceramic strain gauges. The fast rise times and high sensitivities of the piezopolymers cause a lot of unwanted acoustic and vibration pickup. Piezopolymer sensors often require more complex interfacing than the FSR devices. FSR sensors are not as accurate for precise absolute measurement, but they are much more rugged and cost considerably less than strain-gauge sensors.

The construction of an FSR is a sandwich of two polymer films or sheets. A conductive pattern is deposited on one of the polymer sheets as a pattern of inter-

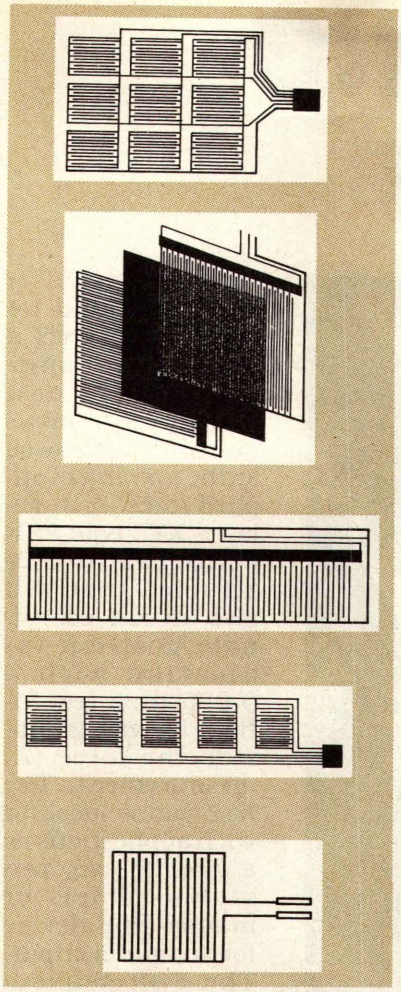


FIG. 1—FORCE-SENSING RESISTORS contain no moving parts to wear out and then can withstand over ten million operations.

TABLE 1—FSR APPLICATIONS

Graphic pads	Suspension sensors
Cursor keys	Accelerometers
Mouse devices	Water-level sensors
Pen stylus tablets	Panel switches
Pressure sensors	Digital tuning controls
Piano keyboards	Joysticks
Toner-level sensors	Game controllers
Foot pedals	Steering wheels
Gait-analysis sensors	Gas pedals
Artificial-limb force sensors	Robotic touch sensors
Dental-byte sensors	Industrial keyboards
IV drip pressure sensor	Deadman safety switches
Bed weight distribution sensor	Smart brake pedals
Security tiles/alarm sensors	Oil-pressure sensors
Load cells	Limit switches

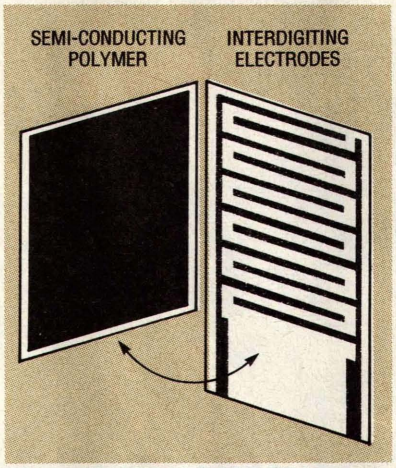


FIG. 2—AN FSR IS MADE OF two polymer films or sheets. A conductive pattern is deposited on one of the polymer sheets, and a proprietary polymer is deposited on the other sheet.

digiting electrodes as shown in Fig. 2. The electrode pattern often looks like a comb, with the teeth and spacing typically being less than one millimeter. Next, a proprietary polymer is deposited on the other sheet. The sheets are then faced together so that the conducting fingers are shunted by the polymer.

The output resistance of the FSR is typically around one megohm with no external force applied. A force-versus-resistance graph is shown in Fig. 3. The graph displays the log/log characteristics of an FSR where the resistance varies from one megohm to around 50 kilohms, depending on the applied force in grams (g). (We know that a gram isn't really a force, but let's just think of it that way for the moment.) Figure 4 shows a force-versus-conductance graph in which a simple linear response is shown from a force of zero grams. A key element in the design of an FSR is the fineness of the pitch of the conducting fingers. The force-versus-resistance relationship is strongly affected by sensor and actuator size, shape, and materials.

Linear potentiometer FSR's

When force-sensing resistors are used to make a linear potentiometer (an FSR-LP), the device can be used to sense both position and applied force. Figure 5 depicts the layered construction of an FSR-LP. When wiring an FSR-LP, a voltage is applied between the hot lead and ground. When a force is applied to the force-sensing layer, the wiper contacts are shunted through that layer to one of the conducting fingers of the resistance strip. The voltage from the wiper is then proportional to the distance along the strip. To sense a force, a resistance measurement is made between the wiper terminal and either the hot or ground lead. Two alternative FSR-LP connection diagrams are shown in Fig. 6.

Force and position measurements are not entirely independent; however, the position measurement can be made unambiguously if the measuring device draws a negligible amount of current (less than 1 microampere) so that there is no voltage drop across the wiper resistance. Therefore, an LF411 or similar op-amp—with a low V_{OS} and I_{BIAS}—is recommended when interfacing to an FSR-LP. Because the contact between the wiper and the resistor is momentary, some kind of sample-and-hold device must be used to interface an FSR; quite often a capacitor between the wiper contact and ground is sufficient to accomplish this.

Force measurements are less ambiguous, and very good approximate measurements can be obtained by shorting the two fixed resistor ends (hot and ground) together, and measuring the resistance between the

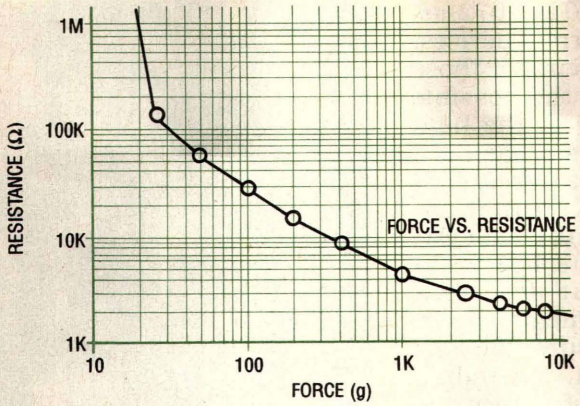


FIG. 3—FORCE-VERSUS-RESISTANCE. The resistance varies from one megohm to around 50 kilohms, depending on the applied force.

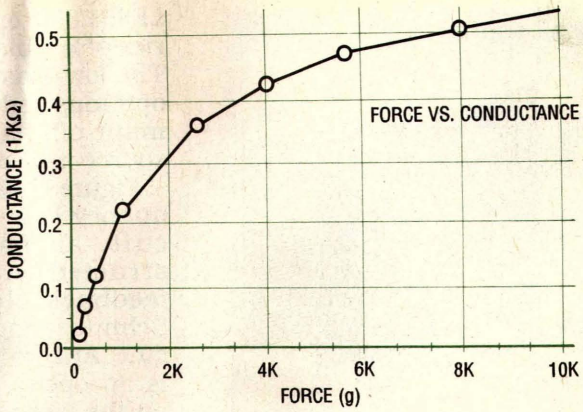


FIG. 4—FORCE-VERSUS-CONDUCTANCE. The linear response is shown from a force of zero grams to 10,000 grams, or 10 kilograms.

combined leads and the wiper. If the force is applied at the middle of the potentiometer, the device will have an additional resistance of one half of the total fixed resistance, because the resulting middle contact parallels the two halves of the fixed resistor. If, on the other hand, force is applied to either end of the FSR-LP's active area, the fixed resistance is essentially shorted out. That problem can be overcome by making the FSR resistance high compared to the potentiometer resistance, therefore making a low-current position measurement a must. The slight force-measurement error can also be subtracted out with a simple analog circuit or, given a position measurement, compensated for in software if a microprocessor is used with the system.

The positional resolution of a force and position sensing resistor (FPSR) depends on the width of the applied force, distribution, and the fineness of the conductive fingers, which is typically in the 10–100 micrometer range.

FSR-LP XYZ

An XYZ pad or tablet is constructed by placing two FSR-LP's back-to-back and perpendicular to each other. An XYZ pad can measure the position of a force on an X-Y coordinate plane, as well as the applied force (Z). Figure 7 shows the layered construction of an XYZ pad. Note that an unambiguous position can be measured only for a single applied force; multiple force contacts will cause false readings. That is not a problem for graphics pads, mouse devices, or pen stylus tablets, but the XYZ pad cannot be used for complex pattern recognition. Position accuracy of an XYZ pad based on FSR-LP's is typically about 1 percent.

A true force sensor will give a constant reading at a constant force, independent of the area over which the force is applied, or its distribution. If a constant force is applied to a true pressure sensor, the reading will be inversely proportional to the area of the applied force. An FSR has a function that is between a force and pressure sensor. A typical FSR will display the resistance of the square root of the area of the applied force. That holds true when the force footprint is smaller than the FSR's active area, and large compared to the spacing between the conductive electrodes or fingers. Because of the sensitivity of the FSR's resistance to the area and distribution of force, the force footprint must be held constant in position and distribution. An elastomeric or rubber overlay placed over the sensor can solve that problem. The FSR can be used as a pressure sensor when the applied force is large compared to the FSR's active area.

FSR devices are designed to be easily interfaced with a wide variety of circuitry. A simple analog interface is shown in Fig. 8. A basic requirement for interfacing an FSR is to ensure that the current through the device does not exceed 1 mA/cm^2 of the activation footprint. The voltage measurement across the FSR is then related to the applied force, and increased pressure results in increased

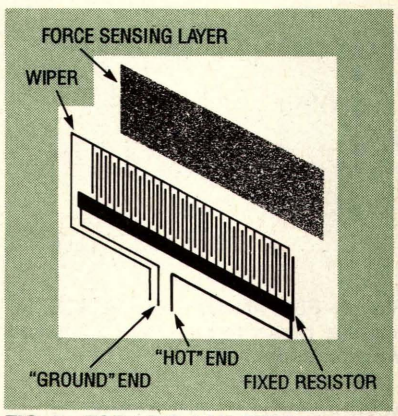


FIG. 5—FSR-LP'S CAN SENSE both position and applied force. This is the layered construction of an FSR-LP.

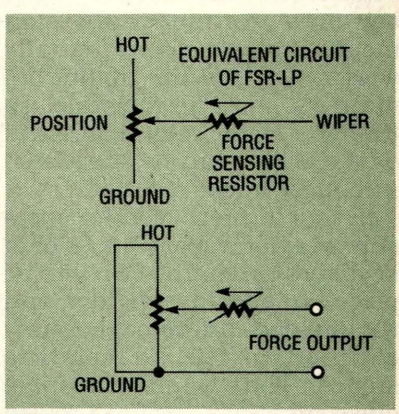


FIG. 6—ALTERNATIVE FSR-LP connection diagrams.

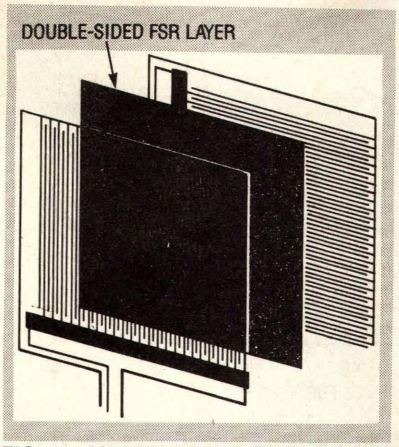


FIG. 7—AN XYZ PAD IS TWO FSR-LP's back-to-back and perpendicular to each other.

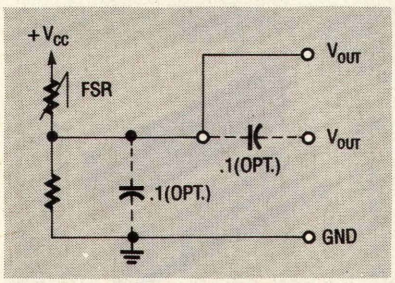


FIG. 8—FSR ANALOG INTERFACE. Increased pressure results in increased voltage output.

voltage output. Precision measurements, however, are a somewhat more difficult because of the shape of the power law curve. For higher precision measurements, it is usually wise to go into the digital domain as soon as possible, so that the log/log characteristics of the device can be translated into more linear results.

If your design calls for measurement of impact (i.e. a data keyboard), then the FSR can be placed in a voltage divider, and the divider can be capacitively coupled to the succeeding stages. That would eliminate offset problems due to a preload condition. The interface shown in Fig. 9 is useful where a higher current or a lower source impedance is necessary. The op-amp can be used either as a unity-gain buffer, or it can be configured to amplify the FSR's output. Offsets can be trimmed by the 500-ohm potentiometer. Gain is set by the ratio of the resistors R_F and R_S. Suggested op-amps for that circuit are the LF351/353 or the TL071/72 series of low bias-current devices. The low bias currents of those op-amps reduces the possible input offsets, due to the high source impedances of the FSR.

Figure 10 shows a force-to-frequency converter. In that circuit, an oscillator is constructed with the FSR as a feedback element around a Schmitt trigger integrated circuit. At zero pressure, the FSR is an open circuit. Depending on the last stage of trigger, the

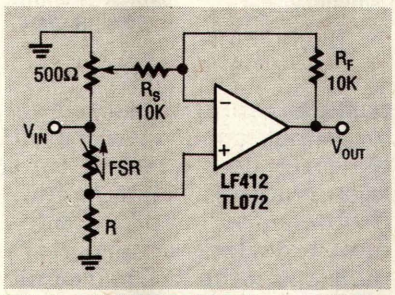


FIG. 9—THIS INTERFACE is useful when higher current or lower source impedance is necessary.

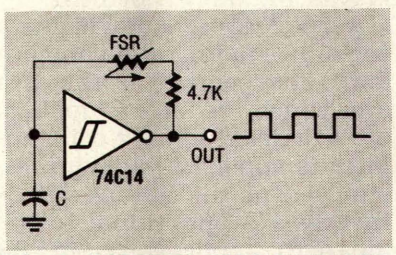


FIG. 10—FORCE-TO-FREQUENCY CONVERTER. An oscillator is constructed with the FSR as a feedback element around a Schmitt trigger.

output remains constant—either high or low. When pressure is applied to the FSR, the oscillator starts, and its frequency increases with increasing force applied to the FSR. Resistor R1 limits the current through the sensor. Bypassing R1 with a capacitor will cause the curve to be steeper at higher forces. Connecting a large-value resistor in parallel with the capacitor (C), quenches any tendency for the circuit to oscillate at low applied forces. When using the circuit with CMOS or TTL, a digital process can be controlled by counting leading or trailing edges of the oscillator output.

Industry-standard connectors, such as pin- or com-

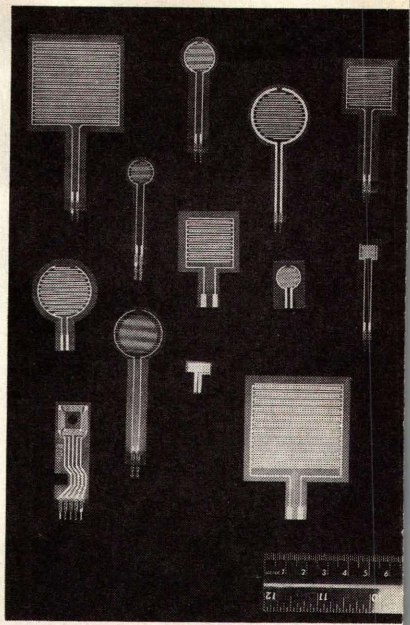
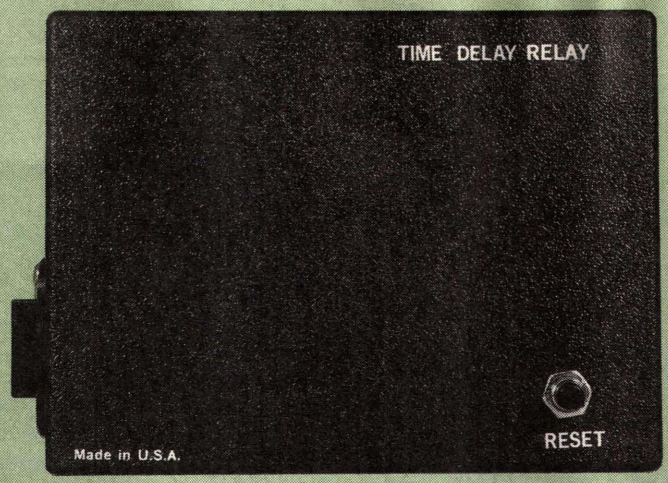


FIG.11—THIS PHOTOGRAPH shows some of the many different shapes and sizes of available force-sensitive resistors. The ruler in the lower right-hand corner gives you an idea of their size.

pression-types, can interface the FSR devices. Conductive adhesives are also commonly used to attach leads to FSR devices. Do not attempt to solder wire leads directly to the polymer sensor, because direct heat will destroy the device.

The force-sensing resistors require a backing for activation accuracy, as mentioned previously. The most unpredictable aspect of the FSR's force/resistance characteristic is the pressure range under 100 grams/cm^2. If you are going to measure small forces with your FSR, you can preload the FSR with a 100–200 gram/cm^2 load and measure the resistance changes. Elastomer or plastic overlays can be used to enhance the FSR's response characteristics by evenly spreading the actuator's force.

FSR sensors are available in many sizes, configurations, and shapes, and custom devices can be designed by the manufacturer. For more information on FSR technology, write on your company letterhead to Interlink Electronics, 1110 Mark Ave., Carpinteria, CA 93013. An evaluation/prototype kit is also available for $79.95. Ω



TIME DELAY RELAY

JAMES MELTON

Stop wasting power—turn off your appliances automatically with an electronic time-delay relay.

OUR TIME-DELAY RELAY WILL DRIVE up to a 3-ampere AC load for a specified period of time, and then shut the load off automatically. It can turn electrical appliances and lights off after a time interval ranging from just a few seconds all the way up to about an hour.

One of the many possible jobs for the relay is the control of indoor Christmas lights—just push a button and the lights will stay on for a few hours, and then automatically turn off. Outdoor Christmas lights, although a considerably larger load, can also be controlled by one of these relays.

The author has several different antennas that are connected to amateur radio equipment in his garage. As a precaution, the feedlines to the radios are routed through mechanical relays that keep them grounded when not powered, and they are connected to the radios only when the reset switch on the time-delay relay is pushed. Several hours later, if he has been called away from the radios (and forgotten that they were on), the relay drops out, and the antennas will have been automatically grounded.

One of these units can even be used with a coffee maker. Quite often coffee makers are left on overnight or over the weekend; the owner returns to find a ruined coffee pot—and a very hot one at that. A time-delay relay in the burner circuit will solve that problem. Simply set the timer to stay on for 2 hours, and if it's not reset, it will allow the coffee pot to cool off.

Operation

The circuit, shown in Fig. 1, is based on a 4060 CMOS 14-stage binary counter with an on-board oscillator driver. The basic frequency is set by the values of R1, R2, and C1, and it's roughly $1/R1 \times C1$. Resistor R2 should be about 10 times the value of R1. The values shown generate an approximate 4.5-hertz frequency, which is then divided down by IC1. Divided outputs are available ranging from divide-by-4 to divide-by-16384 (see Fig. 1).

The chosen output is tied to the base of Q1 through current-limiting resistor R4, and to the base of Q2 through R3. Transistor Q1 is the hold transistor for the timing circuit, and transistor Q2 turns on the solid-state relay.

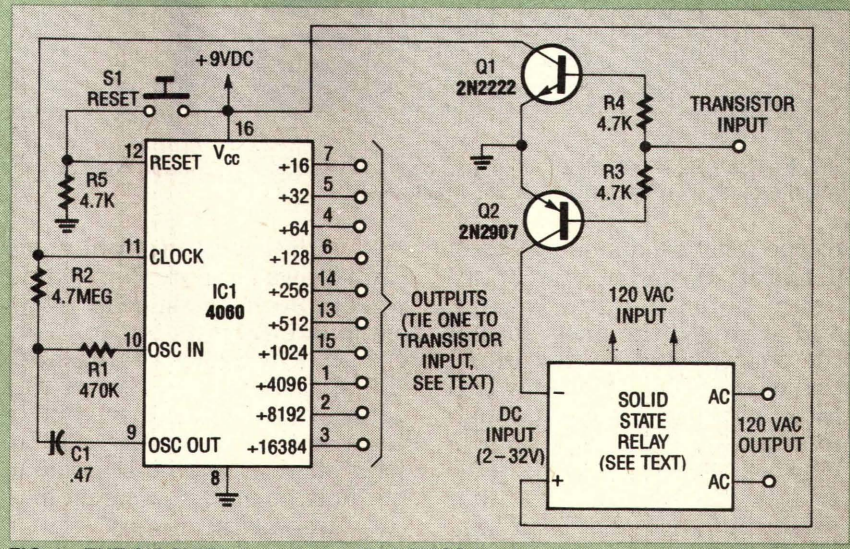


FIG. 1—THE CIRCUIT is based on a 4060 CMOS 14-stage binary counter that controls a solid-state relay.

When you push reset button S1, all of IC1's outputs go low (including the one you have tied to the transistor input). Transistor Q1, an NPN unit, shuts off and its collector, which is tied to timing resistor R2, presents no load to the timing circuit. Transistor Q2, a PNP unit, turns on when a low is applied to its base, thus turning on the solid-state relay.

When the chosen output of IC1 goes high, Q1 turns on, grounding the clock input to IC1, stopping any further counting until S1 is pushed again. At the same time, Q2 shuts off, which turns off the solid-state relay, thus cutting off power to the load.

PARTS LIST

All resistors are ¼-watt, 5%.
R1—470,000 ohms
R2—4.7 megohms
R3–R5—4700 ohms
Capacitors
C1—0.47 μF, 25 volts, tantalum
Semiconductors
IC1—4040 CMOS timer/divider
Q1—2N2222 NPN transistor
Q2—2N2907 PNP transistor
S1—Normally-open pushbutton switch
Miscellaneous: Solid-state relay (sized for the application you have in mind), perforated construction board, wire, solder, AC linecord, project case.

Construction

The author built his prototype relay on a small piece of perforated construction board using point-to-point wiring, and arranged the parts so that the board would mount on the end of the solid state relay (the input terminals are big enough to support the circuit board). Figure 2 shows the inside of the prototype. Note that the author has built in a 9-volt power supply that is not shown in the schematic.

The relay in action

To use the solid state relay, simply plug the relay into a 120-volt outlet, plug an appliance (that draws no more than 3 amperes) into the time-delay relay, and push the reset button. The circuit will begin timing and will shut off at the end of the period you have selected. When you use the time-delay relay to shut off your appliances, you'll not only be adding a safety feature and saving money—you'll also be doing something good for the environment! Ω

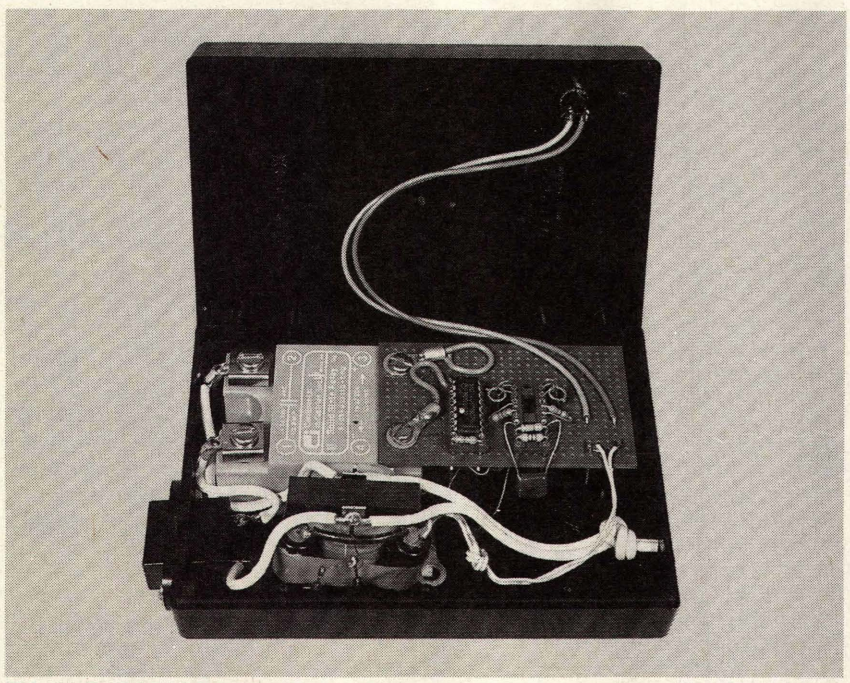


FIG. 2—THE PROTOTYPE RELAY is built on a small piece of perforated construction board mounted on the end of the solid-state relay.

LETTERS

continued from page 17

diovisual phenomenon discussed anywhere. During a TV broadcast of a choir singing, my attention would inevitably focus on an individual singer (usually the cute one), and I would swear that I could hear her individual voice against a background of the entire choir.

Sure enough, when the camera zoomed in on her, she sounded exactly as I had earlier perceived she would. If there were several attractive choir members, I would be able to pick out their individual voices too. The cameraman apparently often agrees with my choices, and pans his camera on the photogenic singers during the performance. I can even keep track of their individual voices with closed eyes.

The same phenomenon seems to occur during orchestral performances, where I seem to be able to isolate individual instruments from the whole orchestra.

I cannot think of a way to test this phenomenon scientifically because what comes out of the speaker is a blended waveform. Thus, the perception must be the result of my visual clues together with the audio. I will chicken out with an escape clause: The human brain must be a wondrous organ if it is able to interpret such fine subtleties from a blended signal. But, all the same, I wonder if anyone else shares my illusions, or is there something more to this?

KELVIN MOK
Edmonton, Alberta, Canada

SILICON CHIP

I was recently looking at *Silicon Chip*, an Australian electronics magazine that had lots of interesting projects in it. It would be good if **Electronics Now** could reprint some of these articles for readers in this country.

WILLIE JONES
Valley Stream, NY

Good news for you! The magazine you mentioned, Silicon Chip, *will soon be in print in this country. See the ad for it on page 25 of this magazine.* Ω

BUILD THIS AUDIO EXPANDER

PHILL HAUSMAN

Enhance stereo and mono audio, for under $30, with our one-chip audio processor.

IT SEEMS THAT EVERYBODY IS AN audio enthusiast these days. With compact discs, stereo TV, hi-fi video tapes, and laserdiscs cheaply available to the general public, nobody wants to settle for ordinary sound. If you build our audio processor, you won't have to settle for ordinary sound either! Our audio processor, which can be built in one evening, can be installed easily between any audio output source and any audio input source, and it can "supercharge" any mono or stereo audio signal.

Some of the many uses for the audio processor include enhancing the audio output from a stereo system or any scanner, shortwave, CB, or ham radio receiver. Stereo and mono TV sound can also be greatly enhanced; a pseudo-stereo effect can be added to a mono soundtrack, and if stereo audio is already in use, you can add enhanced stereo effects. The processor also has amazing effects on old mono or pre-Dolby cassette and 8-track tapes—it's great for doing restoration of old recordings.

Features

The audio processor provides a complete array of controls that give the user maximum flexibility in adjusting the processor. The unit has switch-selectable stereo sound from a stereo source, spatial (widened) sound from a stereo source, and pseudo-stereo sound from a mono source; LED's indicate which mode is selected.

The unit exhibits very low noise (−64 dB minimum) and low total harmonic distortion (maximum THD is 0.5% at 1000 Hz). The input and output resistance is 100 kilohms, which is the standard line-level resistance. The left and right channels provide a minimum of 60 dB separation, and there's an adjustable input attenuator for each channel, which provides a minimum of 70.0 dB attenuation. There's independent gain adjustment of the left and right channels in the spatial stereo mode, and independent gain adjustment of the left and right channels in the mono pseudo-stereo mode.

Theory of operation

The audio processor, whose schematic is shown in Fig. 1, is based on the Signetics/Philips TDA3810N stereo, spatial, pseudo-stereo processor IC. A block diagram of the chip is shown in Fig. 2. The device is essentially a system of internal op-amps used as active filters. The chip contains three op-amp stages, switching circuitry, power-supply regulation circuitry, and LED drivers.

The easiest way to understand how the chip works is to follow the audio signal through the chip for each individual mode.

Stereo mode

When the stereo mode is selected, the left input signal passes through input-attenuator R14, and is coupled via C4 to pin 2 of IC1 (the TDA3810N). The right input signal passes through R15 and C3 to pin 17 of IC1. The various active filters within IC1 serve as a unity-gain bandpass filter with a −3 dB low-frequency cutoff occurring at 20 hertz, and the −3 dB high-frequency cutoff occurring well beyond 20,000 hertz.

Spatial mode

As shown in Fig. 3, when the spatial, or widened, stereo mode is selected, active op-amp circuits selectively remove certain parts of the audio spectrum. The effect is achieved by feeding the audio input to the non-inverting input of an op-amp. The inverting input is fed by the output of the internal buffer/amplifier coupled with a cross-channel signal through R2. Both channels operate in the same way. The gain of each channel can be adjusted independently: R3 adjusts the left channel and R1 adjusts the right channel.

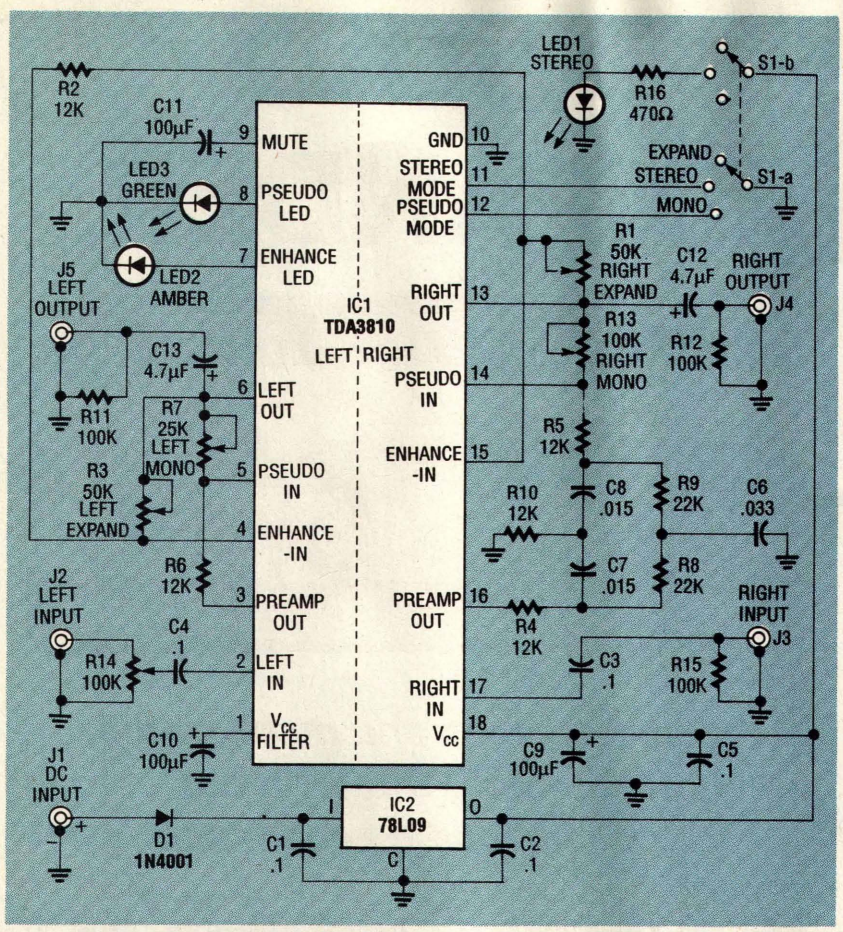


FIG. 1—THE AUDIO PROCESSOR is based on the Signetics/Philips TDA3810N stereo, spatial, pseudo-stereo processor IC.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.

R1, R3—50,000 ohms, panel-mount potentiometer
R2, R4–R6, R10—12,000 ohms
R7—25,000 ohms, panel-mount potentiometer
R8, R9—22,000 ohms
R11, R12—100,000 ohms
R13–R15—100,000 ohms, panel-mount potentiometer
R16—470 ohms

Capacitors

C1–C5—0.1 µF, 50 volts, metal film
C6—0.033 µF, 50 volts, metal film
C7, C8—0.015 µF, 50 volts, metal film
C9–C11—100 µF, 16 volts, electrolytic
C12, C13—4.7 µF, 35 volts, electrolytic

Semiconductors

IC1—TDA3810N audio processor chip (Philips)
IC2—78L09 9-volt regulator
D1—1N4001 diode
LED1–LED3—light-emitting diodes (use three different colors)

Other components

S1—DP3T panel-mount switch
J1—2.1 mm panel-mount power jack (optional)
J2–J5—panel-mount RCA jack

Miscellaneous: 18-pin IC socket, metal project case, 12-volt DC wall transformer (100-mA), 6 knobs, PC board, shielded cable, wire, solder, etc.

Note: The following items are available from HESC, PO Box 12649, Fort Wayne, IN 46864-2649:

- **A kit of parts including a PC board and all parts that mount on it (does not include potentiometers, project case, or wall transformer)—$19.95 + $3.05 S&H**
- **PC board and TDA3810N—$14.95 + $3.05 S&H**
- **TDA3810N—$7.00 postage paid**

Please allow 6 to 8 weeks for delivery.

Pseudo stereo mode

As shown in Fig. 4, when the mono pseudo-stereo mode is selected, the processor creates a "stereo" image using the various active filters differently on each channel. The left channel is fed through a flat-response amplifier (200 Hz to 20 kHz) to achieve a constant gain across the audio spectrum. The gain is adjustable via potentiometer R7, which controls feedback. The optimum setting recommended by Philips, the chip manufacturer, is +2.00 dB at 15 kHz; R7 gives an adjustment range of −69.0 dB to +6.0 dB at 15 kHz.

The right channel uses a twin-T notch filter to give the illusion of signal separation, or the pseudo-stereo effect. Between 100 and 1600 hertz, the notch filter attenuates the audio range by −33.0 dB at its lowest point, which occurs at about 450 hertz. The gain is adjustable by R13, which controls feedback. Philips recommends 0 dB at 15,000 Hz, although R13 gives a range of −68.0 dB to +6.0 dB. Figure 5 shows the frequency response of each channel.

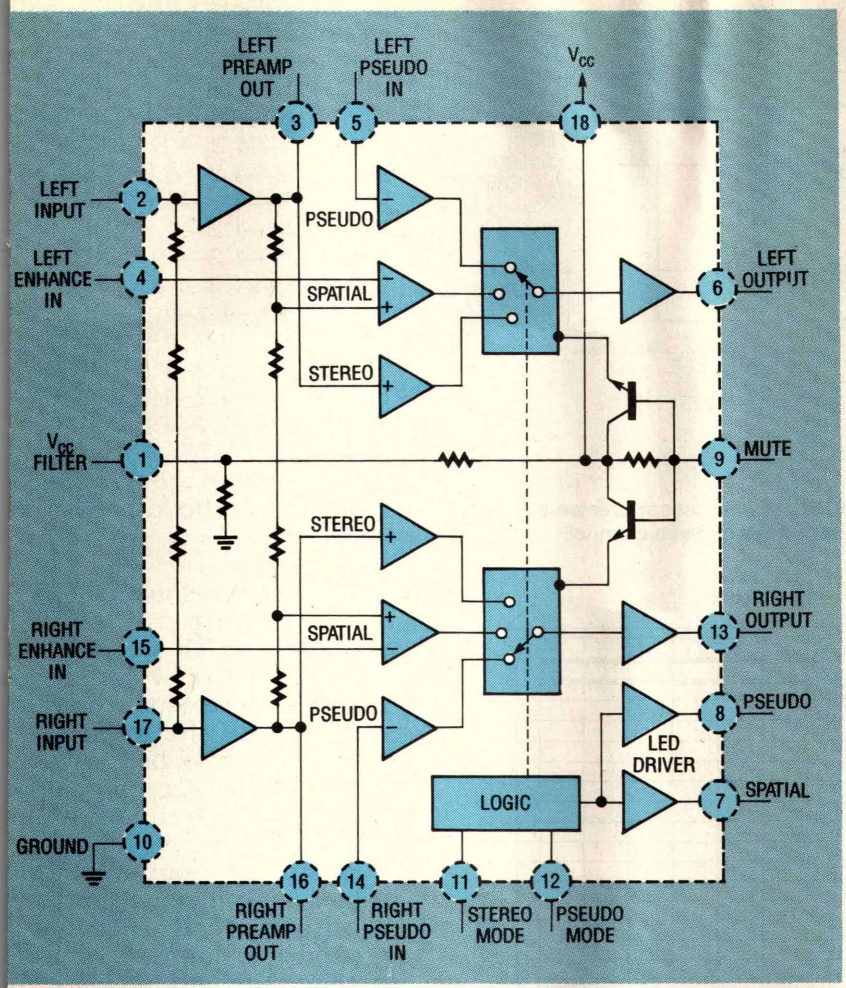
Remaining circuitry

The TDA3810 contains a muting circuit with built-in hysteresis (controlled by C11) that prevents the status LED's from flickering when switching from mode to mode. Also included is the mode selection switch (S1-a and -b) and the corresponding status indicators LED1, LED2, and LED3.

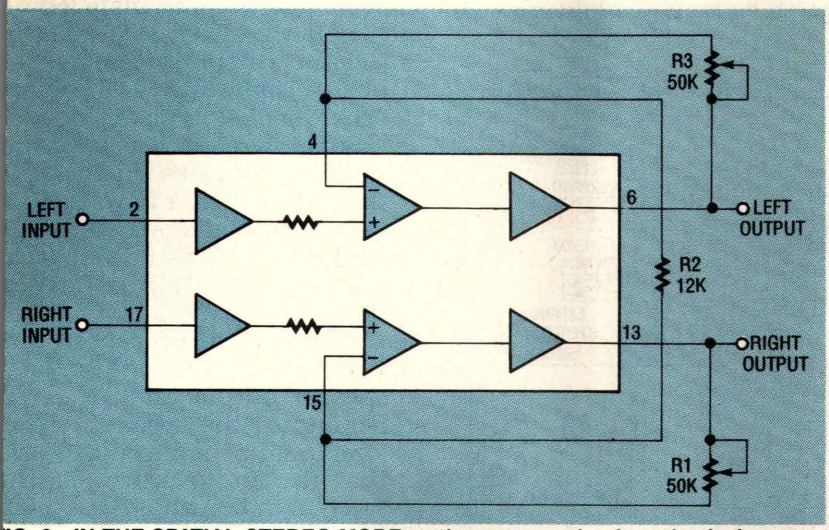
The project requires an external power supply of +10.5–24.0 volts DC, which passes through polarity-protection diode D1 to the input of IC2, a 78L09 +9.0 volt DC, 0.1-amp voltage regulator. Capacitors C1 and C2 provide decoupling and anti-oscillation protection for IC2.

Construction

Most of the parts for the audio processor are available from many electronics distributors. A foil pattern is provided if you want to make your own PC board, or you can use the board available from the source men-



IG. 2—BLOCK DIAGRAM OF THE TDA3810N. The device contains three op-amp tages, switching circuitry, power-supply regulation circuitry, and LED drivers.



IG. 3—IN THE SPATIAL STEREO MODE, active op-amp circuits selectively remove ertain parts of the audio spectrum.

tioned in the Parts List.

Because this is an audio proj- ect, component tolerances and the matching of component val- ues between the left and right channels is important. All resistors should be within 5 percent of the listed value, and it's a good idea to check them. Be sure to use high-quality capacitors, as poor-quality capacitors can adversely effect the overall frequency response of the circuit's processor.

Following the parts-placement diagram in Fig. 6 as a guide, install all resistors and capacitors, paying attention to the polarity of the electrolytics. Also mount diode D1, observing its polarity. Mount the 78L09 voltage regulator (IC2) with the flat side pointing toward the outside edge of the PC board. It's a good idea to use a socket for IC1, and you can install it now and then insert the IC. Observe the proper pin-1 orientation when putting the chip in its socket.

A metal enclosure will provide the best shielding from interference. However, a plastic box will probably be acceptable as well. Prepare the enclosure by laying out the front and rear panels for drilling. After drilling, deburr and clean the enclosure. The author mounted solder posts at each point on the board that must be hard-wired to another component. That made it easy to mount the board, jacks, and controls in the case, and then do the point-to-point wiring. Otherwise, all wires will have to be soldered to the board before mounting it in the enclosure. In either case, mount the completed PC board to the enclosure using appropriate hardware.

If you haven't done so yet, mount all of the potentiometers, jacks J1–J5, the LED's, and switch S1 to the enclosure. Then solder all cables and wires from the board to the jacks and controls. Following Fig. 6, pay careful attention to the places where shielded cable must be used. Hook-up wire can be used for all other connections. When connecting the feedback gain-control potentiometers (R1, R3, R7, and R13), wire them so their resistance *increases* as they are turned clockwise. Figure 7 shows the inside of the completed prototype.

Testing

When the project is complete, check all components for proper location and polarity, and also check your soldering. Using a DC voltmeter, check for the fol-

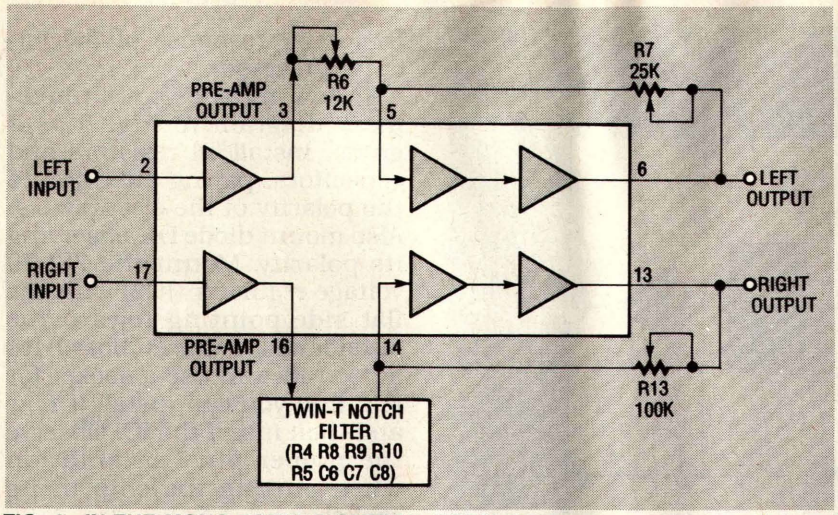


FIG. 4—IN THE MONO PSEUDO-STEREO MODE, the processor creates a "stereo" image using the various active filters in different ways on each channel.

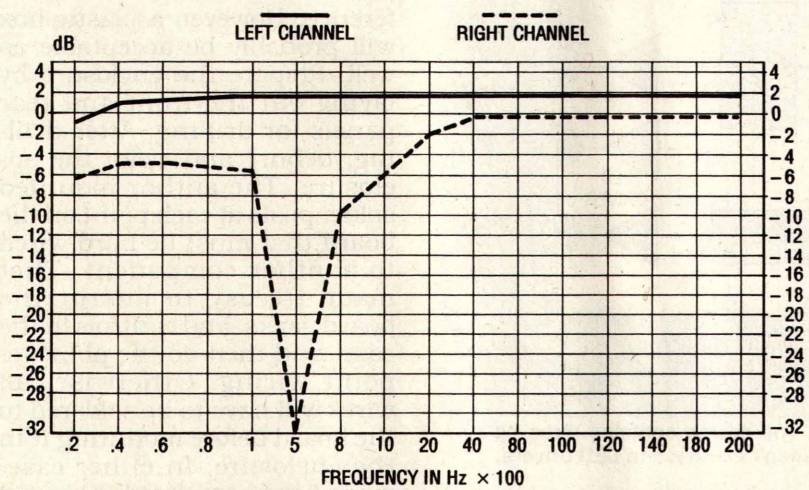


FIG. 5—FREQUENCY RESPONSE of each channel in the mono pseudo-stereo mode.

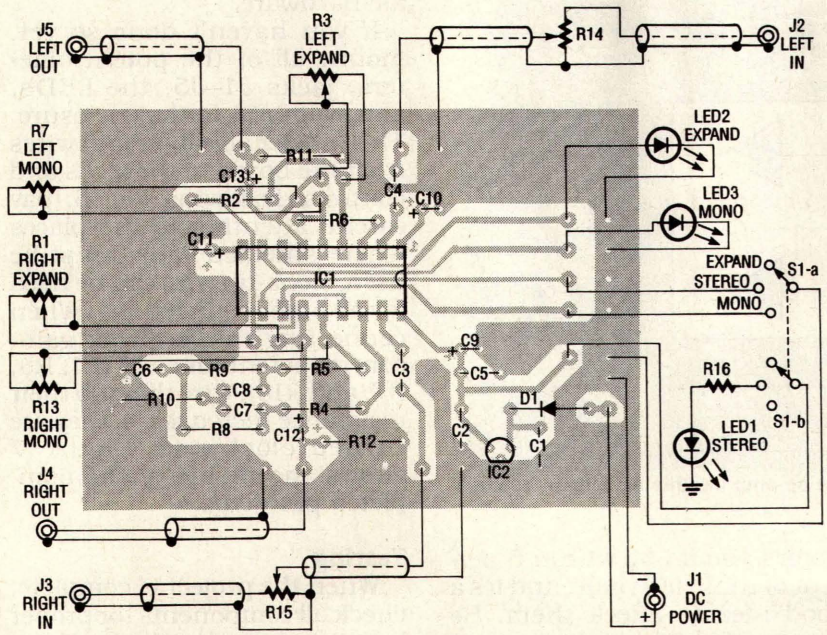


FIG. 6—PARTS-PLACEMENT DIAGRAM. Pay attention to those controls that require shielded cable for connection to the PC board.

lowing voltages after applyin
power to the circuit:
Power-supply output—10.5–2
VDC
IC2 output—8.55—9.45 VDC
IC1 pin 1—4.2–4.8 VDC
IC1 pin 2—4.2—4.8 VDC
IC1 pin 3—4.2—4.8 VDC
IC1 pin 4—4.2—4.8 VDC
IC1 pin 5—4.2–4.8 VDC
IC1 pin 6—4.2–4.8 VDC
IC1 pin 13—4.2–4.8 VDC
IC1 pin 14—4.2–4.8 VDC
IC1 pin 15—4.2–4.8 VDC
IC1 pin 16—4.2–4.8 VDC
IC1 pin 17—4.2–4.8 VDC
IC1 pin 18—8.55–9.45 VDC

If all of those voltages are co
rect, the audio processor i
ready to use.

Installation and use

If the audio processor i
placed near a TV set and tend
to pick up stray interference
move the processor around o
the TV until the interferenc
disappears. Also, be sure to us
a well-filtered DC power pack c
power supply to eliminate hur
from the AC line.

Be sure all input and outpu
cables are shielded, and we
grounded to the PC boar
ground foil. Improper ground
ing can cause ground loops an
other noise problems that ar
hard to track down. When th
processor is to be installed be
tween the TAPE IN/TAPE OU
jacks on a stereo system, hook i
up the same way as if a tap
deck were being installed.

Some stereo TV sets have line
level output jacks on them. I
that case, all you have to do i
install the audio processor uni
between the TV's output jack
and the stereo's auxiliary o
tuner input jacks.

If the audio processor uni
will be installed between
speaker output and an ampli
fier input, the speaker outpu
level must be reduced to a leve
that the audio processor ca
safely handle, which is a max
imum of 2 volts rms. Always se
the input-attenuator potenti
ometers to maximum attenua
tion before applying an inpu
signal to the processor. Connec
all mono audio sources to bot
of the inputs.

continued on page 82

HARDWARE HACKER

Nichrome and resistance wire, epoxy encapsulation myths, semiconductor suppliers III, FCC part-68 phone interface, and copy protection absurdities.

DON LANCASTER

History often repeats itself, first as a tragedy and then as a farce. It sure amazes me how many hardware hackers and software types refuse to learn from the past.

For instance, over a decade ago, the Apple II community conclusively proved beyond a shadow of a doubt that *copy protection does not work*. Never did and never will.

Neither do hardware locks or similar add-ons. Yet many IBM-PC-compatible folks are hell-bent on wasting new time, dollars, and energy reproving this fundamental truth to themselves. You will find only three known effects of copy protection: (a) it annoys and inconveniences legitimate users, sending them all to unlocked competitive products; (b) it diverts time and energy that is best spent improving and updating your code; and, of course, (c) any copy protection dramatically *increases* the number of the bootleg copies of your product that get circulated.

The reason for c is simple. Copy protection *always* attracts attention to itself, causing scads of ultra-creative people to devote countless hours of time and amounts of energy toward cracking the secrets of your product.

The bottom line is this: Undoing copy protection is *fun*! Not only is the challenge fun, it is by far the fastest and most cost-effective way to learn machine-language programming. It's also one of the best and the cheapest high-quality learning experiences you will find anywhere ever—and it's a positively superb entertainment value.

For most hardware offerings, even grinding a part number off the key integrated circuit will have the exact opposite of the intended effect: All that does is cause lots of high-energy people to puzzle out what the chip is and where to get one. The universal hacker popularity for that BA1404 stereo FM broadcaster can be directly traced to one firm stupidly grinding off one too many part numbers.

By far the most absurd notion on hardware copy protection that has been resurrected is to...

Pot it in epoxy!

I simply can't believe the number of calls and letters I've gotten on this lately. Back in the late 1950's, it was conclusively seen that potting your circuits in epoxy offers no design security whatsoever. In fact, epoxy potting will *always* have the exact opposite effect.

First, any reasonably good design engineer could select a "black box" approach and carefully look at the inputs and outputs of the circuit. From the circuit's size and cost, and from information in trade journals, data books, distributor's catalogs, and ap notes, an engineer can easily come up with three or four methods to perform the same function—at least one of which will end up far cheaper, better, and more creative than yours.

Second, it's a simple matter to X-ray any potted project—free even, if it's a small module and you visit a reasonably curious dentist.

Third, most of the epoxy sources also supply *epoxy strippers*. These dissolve out the potting compound, cheaply, rapidly, and conveniently so it can be quickly washed away.

Fourth, epoxy could have several disruptive effects on your circuits. It changes the heat distribution and the operating temperatures of components. It can subtly detune polystyrene capacitors and its weight shifts mechanical resonances to more destructive frequencies.

Fifth, a very little-known fact: The ferrite RF beads used on typical high-frequency analog circuits *must* be able to change in size slightly or they will not work properly. The high-frequency energy gets absorbed by magnetostriction that, in turn, converts to heat. Locking ferrite beads in epoxy can alter their response.

Used with care, there are times and places where epoxy potting is an appropriate technique. Especially for water resistance or use in hazardous environments. But epoxy potting for copy protection just does not work.

Getting Nichrome wire

I've gotten several calls and letters recently asking for hacker sources for Nichrome wire. I'll show you some sources and alternatives in just a bit. But please note that Nichrome is a trade name for a resistive alloy from Driver Harris Co. that can be drawn into wire or sputtered on a substrate.

Most often, you'll want all of your electrical or electronic wiring to be very efficient, wasting as little energy and producing as little heat as possible. But there are other times and places when you want to cause a wire to intentionally generate heat or create a specific voltage drop.

Obvious examples include toasters, electric blankets, hot-wire plastic or foam cutters, laminating machines, space heaters, soldering irons, motor starters, thermal re-

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:

Don Lancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

lays, refrigerator defrosters, or for dummy transmitter loads. Some non-obvious places for carefully controlled resistance wire include current-meter shunts, and sensors that turn your printer on whenever you power your computer.

Most elements, alloys, and other materials are grouped into four types. *Conductors* can pass electricity fairly easily and have low resistances. Conductors can include both ordinary wire and resistance wire.

Semiconductors offer a moderately high resistance to electrical currents, with silicon and gallium arsenide being the most obvious examples. *Insulators* offer very high resistance to electrical current. Rubber, glass, plastics, and ceramics are typical insulators.

Superconductors can offer zero resistance to electrical currents. But most superconductors are complex formulations that work under special conditions at extremely low temperatures. You'll find more on superconductors in the *Hardware Hacker II* reprints.

MATERIAL	RESISTIVITY measured in μΩ-cm	RESISTIVITY as compared to copper
Aluminum	2.8	1.64
Brass	7.0	4.07
Constantan	44.1	25.60
Copper	1.7	1.00
German Silver	33.0	19.18
Gold	2.4	1.42
Invar	81.0	47.00
Iron	10.0	5.81
Lead	22.0	12.79
Magnesium	4.6	2.67
Molybdenum	5.7	3.31
Music wire	11.8	6.86
Monel	42.0	24.40
Nichrome	150.0	87.20
Nickel	7.8	4.53
Platinum	10.0	5.81
Silver	1.6	0.95
Tantalum	15.5	9.01
Tin	11.5	6.69
Tungsten	5.5	3.20
Zinc	5.7	3.34

FIG. 1—THE RESISTIVITY OF ANY MATERIAL is defined as the face-to-face electric resistance of a unit cube. Here are several resistivity values for some of the mo widely used metals and alloys.

Take a one-centimeter cube of any element, alloy, or material. Next, apply a voltage from full face to the opposite full face. Then measure the current. By Ohm's Law, the ratio of the voltage to current determines the *resistance* of the cube. But we have a special name for the resistance of a unit cube. This is the *resistivity*, and is identified ρ, the Greek letter *rho*.

The resistance of a wire increases with its length and decreases in proportion to area. The metric resistivity units are ohm-centimeters (ohm-cm). I'll use a wondrously oddball unit of *microOhm-centimeters* (μΩ-cm) here so our numbers look nicer.

Resistivity values let us compare materials *independent of their actual sizes*. Some popular resistivity values are shown in Fig. 1, while Fig. 2 shows you how much resistance you can expect for various wire sizes of selected materials.

The lowest resistivity of common elements or alloys is silver, checking in at 1.6 μΩ-cm. But silver is fairly rare and readily tarnishes, and the commodity price of silver chang all over the lot. So, silver isn't us too much except for RFI suppre sion microwave equipment, and e otic military stuff.

Copper, of course, is the unive sal choice for a conductor. It has resistivity of a mere 1.7 μΩ-cm- only five percent worse than silv

At first glance, aluminum appea almost as good as copper, having conductivity only 64 percent wors In theory, the thicker but cheap and lighter aluminum conducto could be substituted.

But aluminum has a pair of nas habits which include ele trochemical decomposition and th building up of sapphire-hard (lite ally!) oxide coatings. Making a sol connection to an aluminum wire not a trivial task. Several decade ago, a bunch of house trailer burned up after some abortive a tempts at trying to perfect alum num wiring.

Most of the other popular el ments and alloys have resistivitie that are moderately higher tha copper. But a magic alloy of 61 pe

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cent nickel, 24 percent iron, and 15 percent chrome provides a resistivity over fifty times higher than copper. When combined with its other useful properties, this *Nichrome* alloy makes an outstanding resistance wire.

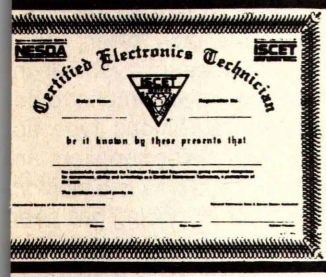
Figure 2 shows you how much resistance to expect for various wire sizes for each of these materials. A foot of 20-gauge Nichrome wire has a resistance of 0.659 ohms. The same alloy in 30-gauge provides around 6.75 ohms total.

Resistance wire gets measured in ohms per thousand feet. Or you may prefer its equivalent of milliohms per foot. Naturally, resistance wire works just like any other resistor, obeying Ohm's law and the usual $P = E^2/R$ power relations. A watt of electricity is, of course, a watt of heat. And a BTU of heat equals 17.58 watts. So you can easily calculate the amount of heat. BTU or *British Thermal Unit* is the amount of heat needed to raise the temperature of one pound of water by one degree Fahrenheit.

MATERIAL	10 gauge	20 gauge	30 gauge	40 gauge
Aluminum	2	17	169	1720
Brass	4	41	419	4260
Constantan	26	260	2640	26,800
Copper	1	10	103	1050
German Silver	19	194	1970	20,100
Gold	1	14	141	1480
Invar	47	477	4850	49,300
Iron	6	59	598	6080
Lead	13	130	1320	13,400
Magnesium	3	27	275	2800
Molybdenum	3	34	341	3470
Music wire	7	70	706	7180
Monel	24	247	2451	25,600
Nichrome	65	659	6750	70,240
Nickel	5	46	467	4750
Platinum	6	59	598	6080
Silver	1	10	98	991
Tantalum	9	91	928	9430
Tin	7	68	688	7002
Tungsten	3	32	330	3350
Zinc	3	33	344	3450

Values in milliohms per foot ~or~ Ohms per 1000 feet.

FIG. 2—SOME TYPICAL RESISTANCE VALUES for different materials and wire gauges.



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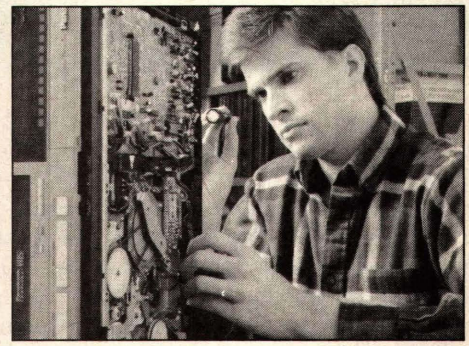

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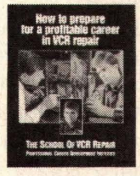

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Other resistance-wire variables include the tensile strength, the temperature coefficient of resistance, and the temperature coefficient of expansion. The resistance-temperature coefficient gets important fast in such things as meter shunts. The expansion temperature coefficient becomes crucial if the wire passes through some ceramic seal. Should the wire and the ceramic expand at different rates, one or both can self destruct at high temperatures.

The fastest and simplest way to get some Nichrome wire to play with is to gently crush up a surplus power resistor in a vise and unwind the wire. Different sizes offer different lengths and gauges of wire. Resistance wire often ends up at surplus stores at bargain prices, especially at *Fair Radio Sales*. *American Science and Surplus* also offers cheap resistance wire originally intended as refrigerator defroster elements.

One big supplier of new resistance wire is *MWS Wire Industries*. Its equivalent to Nichrome is known as MWS-675. It also offer two dozen other variations. Its MWS-875 provides even higher resistivity with better temperature coefficients for both resistance and expansion. This alloy includes chrome, aluminum, and iron, with traces of carbon and silicon. It is also slightly lighter in weight.

By the way, other trade names for alloys similar to *Nichrome* are *Trophet C*, *Alloy C*, *HAI-NiCr60*, *Chromel C*, *Nikrothal 6*, and *Electroloy*.

For this month's contest, just te
me about a new or unusual hacke
use for resistance wire. There'll b
all of the normal *Incredible Secre
Money Machine II* book prizes
along with an all-expense-paid (FOE
Thatcher, AZ) *tinaja quest* for tw
going to the best submission of al

As usual, send your written en
tries to me here at *Synergetics* an
not to the **Electronics Now** edi
torial offices.

A hacker interface

In several past columns, we hav
looked at the FCC *Part 68 Inte
faces*. These are required any tim
you want to put voice, music, calle
ID data, or modem tones on or off c
the phone line. The key componen
needed is just a fancy transforme
with a high isolation voltage rating,
very good balance, and the ability t
accept DC primary current.

There are lots of dollars, time, an
effort needed to get an interface
FCC type approved. And *it is nov
illegal to make any connection t
the phone line without goin
through an FCC approved, Part 6
interface*. At least in the U.S.

Several firms now offer "pass
through" interfaces that you can in
clude within your own circuits to ge
an instant and automatic type ap
proval. The two major suppliers are
now *Cermetek* and *Dallas Semicon
ductor*. Sadly, their pricing has beer
too high for most hacker uses.

A startup outfit by the name o
CircuitWerkes is now offering a new
and hacker-friendly Part 68 interface
at an acceptable price of $29.95
And yes, it offers a full type-approva
pass through. It's subject to only a
few easy rules that involve compo-
nent spacing, labels, documents,
and modifications. Figure 3 shows
you the circuit.

A small relay makes the *on-hook*
and the *off-hook* state connections.
To "sieze" or "answer" the line, ap-
ply 12 volts DC to the relay, provid-
ing 60 milliamperes.

The ring-detector circuit is active
only when on-hook. It consists of a
optoisolator that responds to the
high AC ringing voltage (typically
140 volts at a frequency of 28 to 40
Hertz). The output of the ring detec-
tor is an open collector. You'll have
to provide both an external pull-up

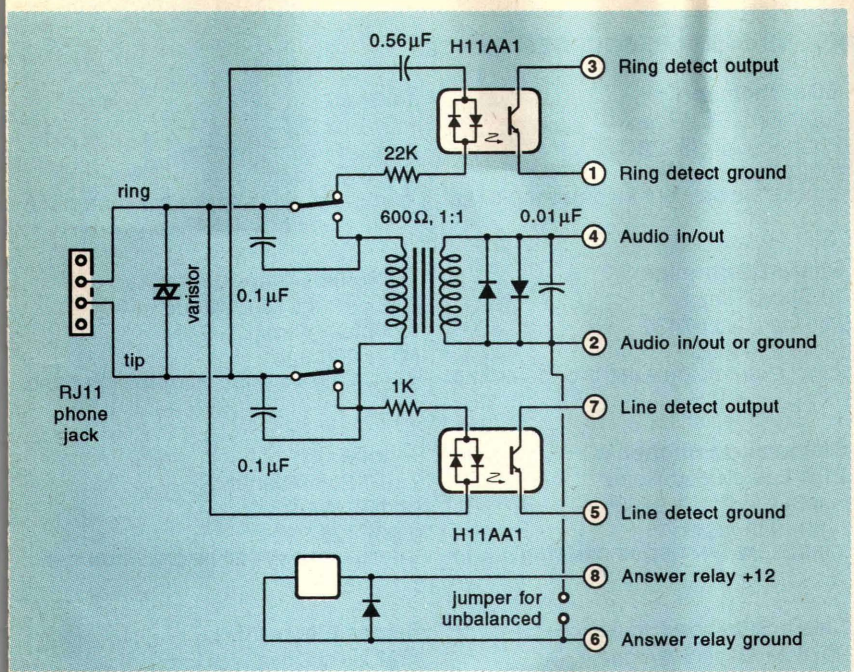

FIG. 3—THE CIRCUITWERKES MPC-2 is an FCC Part-68 telephone interface that offers a "pass through" type approval for your own hacker projects.

resistor and a filter capacitor to ground. Suitable values are 12,000 ohms and 5 microfarads.

The main data path is active both on- and off-hook. This dual feature is needed for a caller-ID compatibility. When you are on-hook, the data path is capacitor-coupled.

When off-hook, the data path is DC-coupled through the transformer primary. A second optoisolator in parallel with the primary acts as a line-current detector. The line current is detected by monitoring the DC *voltage* drop across the primary.

The line-current detection lets you know when your calling party hangs up. The optoisolator also offers open-collector output. A pull-up resistor is also required here.

The main data path is a special transformer with two clipping diodes that limit the maximum applied audio. A jumper option allows you to select a balanced or single-ended 600-ohm source/sink for your audio output.

Typically, your computer will first monitor the ring detector. After a ring, it seizes the line and optionally grabs the caller-ID tones. Then it will send or receive your voice or data. Finally, you can hang up by causing the relay to drop out—either by detecting the absence of line current or by hanging up on purpose.

As a second contest for this month, just tell me about a new or unusual application for a hacker-legal Part 68 interface project.

Much more information on those caller-ID applications appears in a dozen files on my *GEnie* PSRT.

More semiconductor resources

We will wrap up our continuing listing of the major semiconductor houses in a third and final sidebar.

This month, we will cover *OKI* up through *Zilog*. I've tried to zero in on those suppliers with the greatest hacker interest.

A complete list will appear in the *Hardware Hacker IV* reprints. I've also gathered them together into the ICMFGRS.PS download you'll find on *GEnie* PSRT.

As we have seen before, your best bet here is to request a short-form catalog, the price list, and a literature directory. Be absolutely sure to use professionally sounding phone calls or your own custom PostScript laser letterhead. A ball-point pen on tablet paper flat out won't hack it. Much more on finding and using technical information is in my newly revised *Incredible Secret Money Machine II*.

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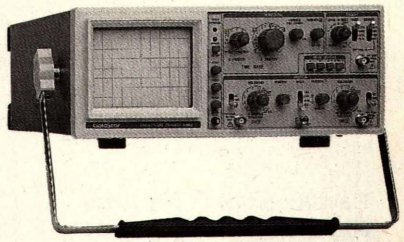

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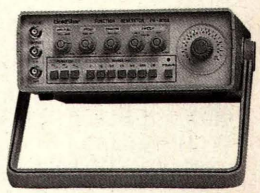

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ew publications for this month. The rst is Dick Oliver's new *Nonlinear Nonsense*, a free quarterly newsletter on fractal modeling, chaos science, artificial life, and creative graphics. His 3-D fractal design software is also being offered commercially.

Also free on professional request is the new *Spread Spectrum Handbook* from *Stanford Telecomm*. This is a dozen pages of ap-notes and useful references, along with bunches of data sheets for the company's high-end digital spread-spectrum chips.

The *Scrambling News* has detailed insider information on the current TV video scrambling and descrambling methods. It also offers books full of schematics, modifications, and related technical information. A competing newsletter is the *Satellite Watch News*.

The *SRS Encoder* is a new monthly newsletter from the *Seattle Robotics Society*. Lots of regional information on great surplus buys are included here.

Joe Singer's *Printer's Devil* is a superb alternative publication on home printing and presswork. "A press in every home; a home in every press." It is published quarterly at a bargain $10 per year subscription price.

Finally, the *New Age Alternatives Discount Catalog* is another resource for pseudoscience devices and information. Fascinating reading for sure. This one is offered by *Lor'd Industries*.

A reminder here: I have reprints available for most of my columns. Both in *Book-on-demand* published hard copy and on-line at *GEnie* PSRT. The titles now include my *Ask the Guru*, *Hardware Hacker*, the *Blatant Opportunist*, *LaserWriter Secrets*, and the new *Resource Bin*. Check my nearby *Synergetics* ad for more details.

As usual, I have gathered most of the mentioned resources together into our *Names and Numbers* and *Semiconductor Manufacturer's III* sidebars. Also, as usual, you can get technical help, consultant referrals, and lots of off-the-wall networking by calling my helpline. Ω

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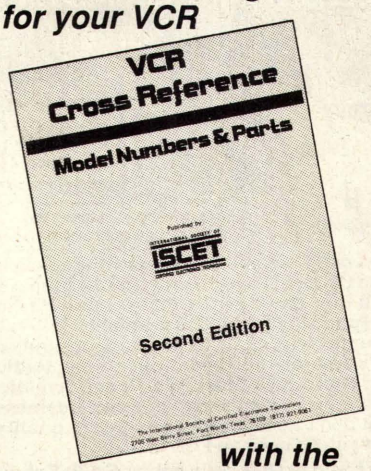

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AUDIO EXPANDER

continued from page 74

In the stereo mode, the only adjustments are the input-attenuator controls (R14 for the left and R15 for the right). For a line-level input, set them for 0 attenuation. Other higher-level sources should be adjusted as desired by the user (without exceeding the 2-volt rms maximum input limit).

In the spatial stereo mode, the input attenuator control should be adjusted the same way as in the stereo mode. The spatial controls (R3 for the left and R1 for the right) can then produce very interesting spatial effects. Also, adjusting the input-attenuator controls produces interesting effects due to the cross-channel coupling provided by resistor R2. Experiment with those four controls to determine their optimum settings.

In the mono pseudo-stereo mode, the input-attenuator controls should be adjusted the same way as in the stereo mode. The pseudo stereo controls (R7 for the left and R13 for the right) should be set as follows: R7 should be set to give a +2.0 dB higher output level versus the right output channel control (R13). For example, set R7 for an output of +2.0 dB, and set R13 for an output of 0 dB. The specific levels are not critical; just keep a 2.0 dB differential between the left and right output channels.

When using a mono input source, the spatial stereo mode will produce some very interesting and useful effects. The input attenuator controls will also have interesting effects. Ω

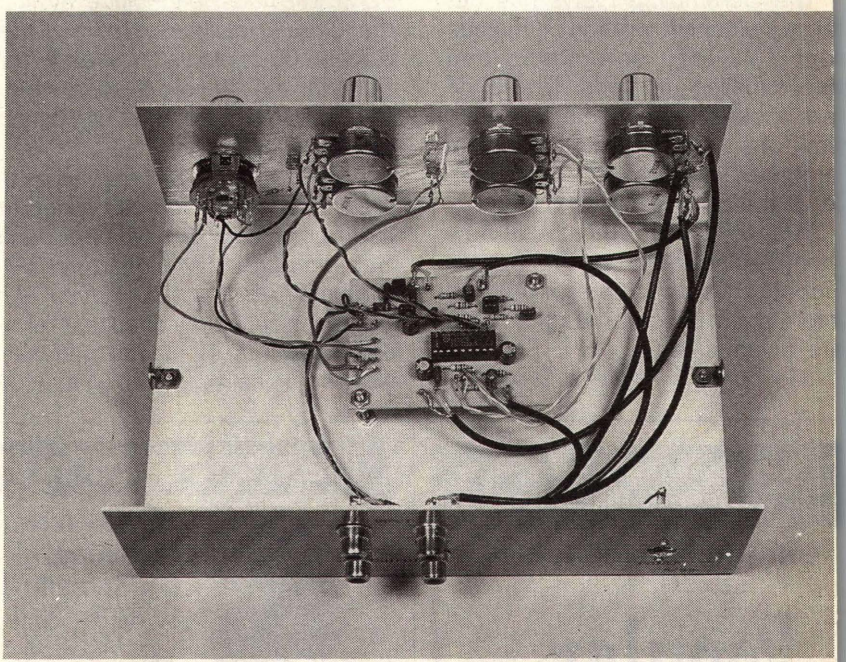
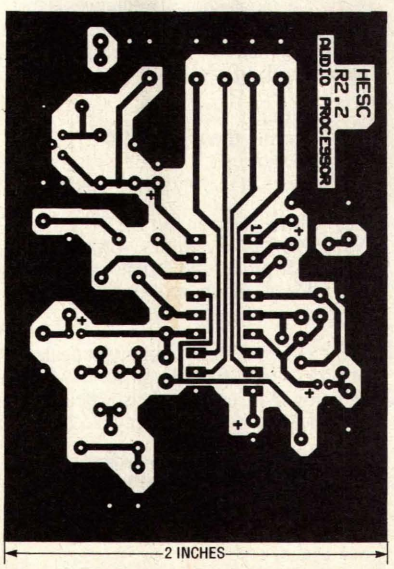


FIG. 7—A METAL ENCLOSURE provides the best shielding from interference. Here's the inside of the completed prototype.



FOIL PATTERN for the audio processor.

REMOTE CONTROL TESTER

BY A.E. PLAVCAN

INFRARED REMOTE CONTROLS ARE very common these days, thanks to all the video, audio, and VCR equipment on the market that can be controlled with an infrared remote. Remote controls are great when they work properly. However, it's very frustrating when you press a button on the remote control and nothing happens. If you've ever had that problem, then you know what we mean when we say it's frustrating.

It's always hard to know whether a malfunction is due to the remote control or the device you are trying to control. After all, infrared (IR) is invisible to the human eye, so how do you know if the control is working?

The answer is simple: Build our IR remote-control tester. It will let you know if, when you press the button, the control is emitting an IR signal.

The IR tester circuit is shown in Fig. 1. IR phototransistor Q1 receives the signal from a re-

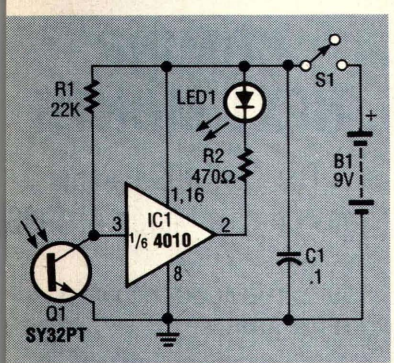


FIG. 1—THE IR TESTER circuit lets you know if the button you press on a remote control is working.

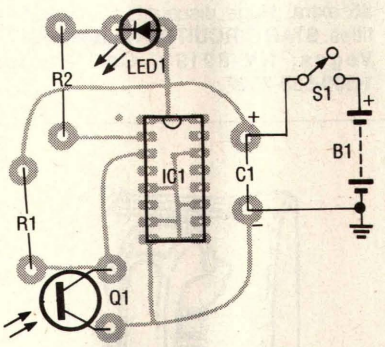
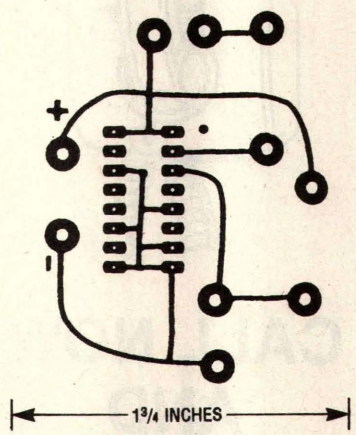


FIG. 2—PARTS-PLACEMENT diagram for the IR tester. Point-to- point wiring can also be used.



FOIL PATTERN for the IR tester circuit.

PARTS LIST

R1—22,000 ohms, l/4-watt, 5%
R2—470 ohms, l/4-watt, 5%
C1—0.1 µF, ceramic
IC1—4010 CMOS hex non-inverting buffer
LED—light-emitting diode, any color
Q1—SY32PT IR phototransistor or equivalent
B1—9-volt battery
Project case, PC board or perforated construction board, battery clip, wire, solder, etc.

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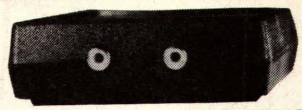

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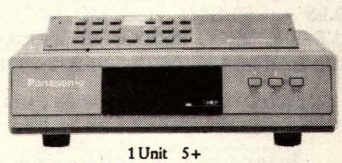

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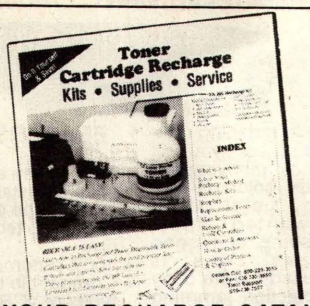

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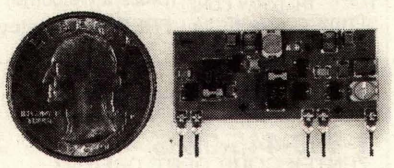

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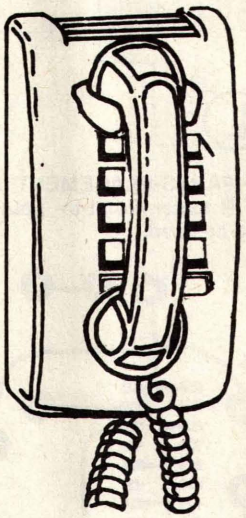

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mote control and sends it to or
gate of a CMOS 4014 non-inve
ting hex buffer. The output fro
the buffer drives an LED th
flashes the received signal to l
you know that the remote co
trol (or at least the one butto
you pressed) is working an
emitting an IR signal.

We've provided a foil patter
to make a PC board for this pro
ect, but the circuit can easily b
made using point-to-point wi
ing. Figure 2 shows the part
placement for the PC boar
should you decide to use it. Th
completed circuit can be i
stalled in any suitable cas
Mount the IR phototransist
where it can easily receive the I
signal, and mount the LE
where it's easy to see. A 9-vo
battery powers the circuit, bu
you can certainly build an A
powered supply if you wish.

Once constructed, the test
will determine if your remo
control is causing the problen
Simply point the remote contr
at the IR phototransistor, an
press each button. The LED wi
flash for proper operation.

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AUDIO UPDATE

The Audio Answerman: Part 1

LARRY KLEIN

Here is another collection of helpful (or at least interesting) audio questions and answers from reader mail and my files.

udio education

I've been intensely interested in usic recording and audio technology ever since my early teens. At is point, I'm seriously considering try into the audio field in a professional capacity. Where can I get information about my options and the ducational requirements?
M.
orwalk, CT

You're in luck. A definitive irectory of Educational Programs as been published by the Educaon Committee of the Audio Engieering Society (AES) that covers ourses ranging from seminars to ur-year graduate programs that rant degrees. Institutions, facilies, courses, degrees, and tuition e listed in a convenient format.

As a bonus, there are helpful artiles that discuss the variety of job pportunities within the field and ays to approach the education rocess. The postpaid cost of the irectory is $5 for AES members, 6 for nonmembers. Delivery is 4 to weeks. Send your check to Audio ngineering Society, 60 E. 42nd St., oom 2520-RE, New York, NY 0165. While you are writing, you ight also ask for an AES membership application.

lat sound

Recently I told a friend that I built ny own speakers from scratch. To ny annoyance, he immediately sked, "How flat are they?" Are we etting so wrapped up in specifications that we forget the basic goal—ood sound the way we like to hear ? I spent over 50 hours reworking ny ported speakers so I could have lot of bass—the way I like it. Don't get me wrong; specs and test reports are definitely helpful, but keep in mind that I'm spending money to have sound the way I want to hear it—not as some expert says it should be heard.
P.W.
Rochester, NY

If P.W. had written about choosing the paint color for his living room walls or selecting a blend of coffee—or a wife—I would not argue with the subjectivity of his approach, although my own tastes would probably differ. Everyone has a right to his own tastes—however absurd they might be. I assume you are using "good" in the sense that it satisfies you. However, when the goal is to reproduce a recorded sound, then the system that's doing it must not add any special sound characteristics of its own. If P.W. prefers speakers that readjust the original tonal balance of the program material in a given direction, that's his privilege. But I must point out that his speakers, by definition, are then not providing high-fidelity reproduction. Theoretically, fidelity to some original is what hi-fi is all about.

Planned obsolescence

I use my audio equipment at least four hours a day, and next year my receiver will be 10 years old. How does wear affect audio equipment, and how long will it be before planned obsolescence sets in?
H.S.
Elliston, VA

Congratulations to your receiver on its 10th birthday! Before I answer your question on wear, I'd like to discuss "planned obsolescence," a term that seems to be fading from popular use. Actually, the alleged practice that the term describes never did make much sense; what most people really meant by it was planned deterioration. In other words, certain parts or components in a device supposedly were designed to have both a short life and a high replacement cost, thereby encouraging the purchase of a new replacement. But it seems to me that the ill will engendered by premature breakdown would cause consumers to avoid the faulty brand when considering a replacement—thus defeating the purpose of the alleged planned obsolescence.

The loudest complaints of planned obsolescence usually occur when a new audio format threatens to render obsolete someone's treasured collection of program material. For example, the industry switched from from 78 rpm's to LP's, LP's to cassettes, and then cassettes to CD's. The obsolescence in those cases was, truthfully, planned to obtain higher fidelity—or in the case of cassettes, greater convenience—for the music collector and listener.

The general public (unlike some of the audio magazines and syndicated columnists) does not automatically extend a warm welcome to every new trend in audio. Witness, for example, the marketplace fiascoes of such components as the "elcassette" and, lately, DAT. I suspect that there are other fiascoes of the digital variety now waiting in the wings.

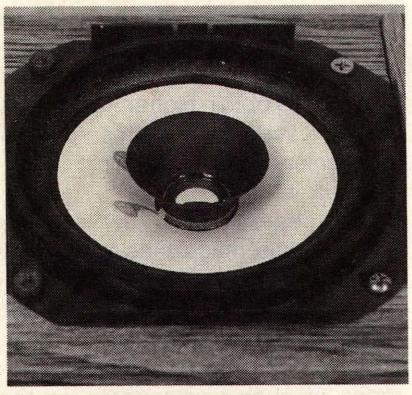
In regard to your question about wear, solid-state devices, unlike high-power vacuum tubes, do not have an inherently short life. This is not to say that transistors never fail, but rather that their predicted life span extends far beyond that of tubes. Because of minute manufacturing flaws, small-signal transistors (and integrated circuits) can develop leakage over time, and power devices ultimately can flex themselves to death from repeated heat-

ing and cooling cycles during normal use. Other components, such as electrolytic capacitors, fail over time for a variety of mechanical and electrochemical reasons.

Whizzers

I'm curious about the speakers installed in the lower front-door panels of my car. I removed the grille from one of the speakers and found it to have a single gray 6-inch cone with a separate small white cone cemented to its center. Does the smaller cone serve as a tweeter?
D.C.
Lancaster, PA

Sort of, but not really. What you've described is known as a "whizzer," and its purpose is to enhance the high-frequency sound from your speakers. A whizzer is a small, light, and stiff subsidiary cone with an unsupported outer edge that is cemented to the center of the main cone. The area of attachment is directly over the driver's voice coil. The whizzer picks up the higher frequency vibrations from the voice coil, and helps to send them out into the world as sound.



HERE IS A WHIZZER CONE attached to a low-cost speaker.

If carefully designed, a whizzer can provide improved highs from larger, full-range drivers. Obviously, the manufacturing cost of adding a whizzer to a driver is very low compared with the cost of a separate tweeter with its crossover and mounting complications. On the other hand, a separate or coaxially mounted tweeter is able to put out significantly more high-frequency energy—which you could probably use considering the calf-high mounting location of your speakers.

X-ray problems

Despite the printed reassurances posted at the passenger inspection areas of airports, I've always tried to keep my films and tapes from being X-ray inspected. I recently heard that color TV sets can also produce X-ray radiation. How far away from my TV should I keep my audio and video tapes to be safe, or will it not make a difference?
M.O.
Burlington, VT

As far as I can determine, X-rays at the levels used in baggage examination have no effect on tapes or the signals recorded on them. It's true that the stray magnetic fields produced by X-ray equipment and color TV cathode ray tubes might affect a recorded signal, but one expert told me that the tapes would have to be stored inside the operating equipment in close proximity to a transformer or deflection coil before an erasure is likely to occur. However, metal detectors, also used in airports, can be hazardous to the health of your recorded tapes.

Parameters

"Parameter" seems to have become a new catchword among those involved with politics and/or the Pentagon. Is "parametric" derived from the same word, and exactly what does it have to do with equalizer design?
J.H.
Chevy Chase, MD

My copy of Webster's dictionary defines parameter as "A (mathematical) quantity or constant whose value varies with the circumstances of its application, as the radius line of a group of concentric circles, which varies with the circle under consideration." The adjectival form is "parametric." In other words, a parametric equalizer does not limit you to the specific built-in fixed operating frequencies and bandwidths of a conventional graphic equalizer. Instead, you can assign "arbitrary values" as the equalization needs arise. This can be very handy, for example, when the frequency of the peak that you want to reduce doesn't line up very well with one of the sliders on a standard ⅓-octave graphic equalizer. Ω

Q&A

continued from page 12

graphics image. The second, le expensive alternative is to print 150-dpi resolution—half the numb of dots means half the memory quirements. If you can live with lower resolution, the latter is cheap, quick fix for the problem.

There's one more possible swer to your problem but I do that it's applicable. It may be t you have enough memory in printer to do 300-dpi, but you using the memory to hold dow loaded fonts and other things. member that memory used for fo isn't available for graphics. Che your software (and not just graphics stuff) to see whether t is true or not. If it is, unloading fonts may free up enough prin memory to permit you to pr graphics at the maximum 300- resolution.

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DRAWING BOARD

Our descrambler is almost finished.

ROBERT GROSSBLATT

Believe it or not, there's not a lot more to the design of the basic descrambling circuit han the subject matter we've covred over the past few months. But you're really interested in video, here's much more for you to earn—the video-scrambling stuff 've been going through is just ne small part of the subject. Video a complex business, and once ou get the hang of how signals can e manipulated, you'll find that here's no end to the kind of circuitry ou can design. There's also a huge narket for it as well. But back to the ubject at hand.

When we first started work on the SAVI descrambler, the block digram probably looked quite comlex. But if you look at Fig. 1, you'll ee that most of the work has been one. The most difficult job left for s is to come up with the counter hat's needed by the phase-locked oop. It's a job we have to do careully because the success of the descrambler depends on how well we an maintain the stability of the horiontal-sync signal.

The phase-locked loop in our design is driven by a 504-kHz clock based on an R-C network. That frequency was chosen for two basic easons: The first is that it's exactly 32 times the NTSC line frequency of 15,750 Hz, and that makes it easy or us to do the division necessary o produce horizontal sync pulses. The second, and somewhat more subtle reason, has to do with the period rather than the frequency.

A 504-kHz clock has a period of .98 microseconds. That's interestng because, by using five of the counts, we can get a pulse that has a width of 9.92 microseconds, which is close enough to the NTSC's established standard of 10.7 microseconds for a horizontal blanking pulse.

Before we go any further, I have to comment on my apparent disregard for precision. I've been using language and design techniques that are loaded with phrases like "close to," "pretty much the same as," "in the ballpark," and so on. Now, I'm as impressed with standards as anyone I know, but numbers have to work in the real world as well as on paper. You have to keep things like cost in mind when you're designing a circuit.

The NTSC standards for a video signal have a precision of several decimal points, and every broadcaster in the country spends a lot of time and effort making sure his signal adheres to that standard. The same is true of TV manufacturers, as well. The theory for standardization is terrific but, as is usually the case, what happens in reality is different. All you have to do to see what I mean is put a scope on the video signal received by your TV set; you'll find an overall similarity to the video standard, but you'll be amazed at how sloppy the signal really is. The average horizontal frequency might be 15,750 hertz, but there's considerable jitter from line to line in the signal. The same is true for burst, blanking, and all the other components in the line.

Despite these variations in the signal, the picture that shows up on your TV screen is apparently unaffected by them. The difference between studio-quality video (the stuff on the monitors in the broadcaster's control room) and received video (the stuff you see on your TV) is minimal.

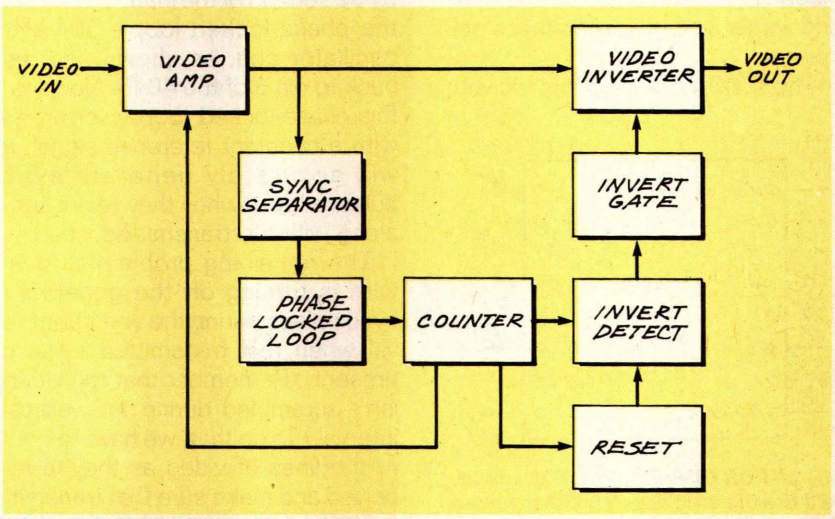

FIG. 1—MOST OF OUR BLOCK DIAGRAM has already been turned into actual circuitry. Now we need a counter for the phase-locked loop.

Keeping all that in mind, let's design the rest of the descrambler.

The next thing we need is a divide-by-32 counter to complete the phase-locked loop section of the circuit. After my discussion of the relative importance of precision, you should understand why the phase-locked loop's oscillator is only RC-based, and not crystal controlled: It's just cheaper and easier.

The divide-by-32 circuit (the "Counter" in Fig. 1) can be built in

several ways; as a matter of fact, we've designed a whole bunch of these things in the past. In order to keep the circuit as simple as possible, we'll use the 4040 binary counter whose pinouts are shown in Fig. 2. This is one of the earliest members of the CMOS family and still one of the best choices for general counting. It's a ripple counter, rather than a synchronous counter, so don't use it for applications where super accuracy is required. Remember that a ripple counter is a bunch of sequential counters, and each internal stage uses the output of the preceding stage as an input. This means that the outputs change in sequential order, and an incorrect count will be present briefly on the pins. Since the problem is caused by the propagation delay of each counter stage, the duration of the incorrect count on the outputs is, by and large, a function of the clock speed.

The 4040's clock input is fed with

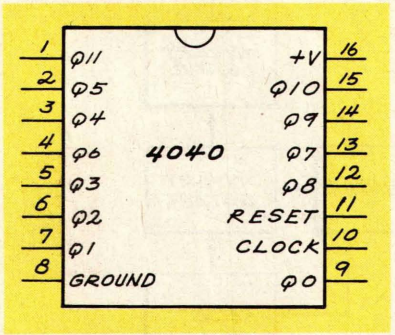

FIG. 2—FOR OUR DIVIDE-BY-32 circuit, we'll use the 4040 binary counter whose pinouts are shown here.

the 504-kHz signal generated by the 4046, and we're using a series of gates to decode the count and provide horizontal blanking and some other timing signals needed for the descrambler. The actual circuit is shown in Fig. 3. You should understand why each of these signals is needed before you start hooking everything up to the back of your TV set. To see what we need from the counter, let's use it to restore horizontal sync and then figure out what else we need to completely unscramble the incoming video.

Getting a horizontal sync clock for the phase-locked loop circuit is simple. All we have to do is pick off

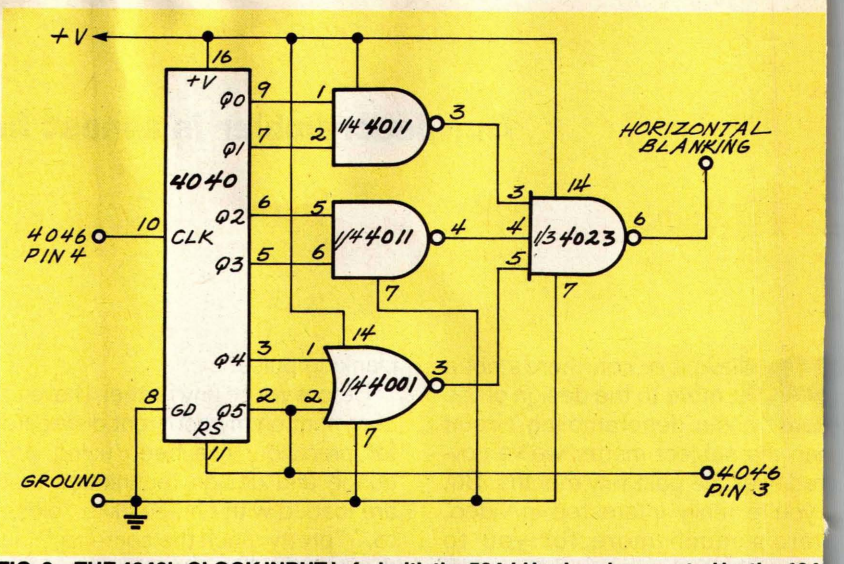

FIG. 3—THE 4040's CLOCK INPUT is fed with the 504-kHz signal generated by the 404 We're using a series of gates to decode the count and provide horizontal blankin

the Q4 output. That is a divided-by-32 version of the input clock from the phase-locked loop's 504-kHz oscillator and, as shown, it's fed back to pin 3 of the 4046. Now that the phase-locked loop is provided with a constant reference signal, it will accurately generate sync pulses—even when they're not sent along with the transmitted video.

The remaining problem to deal with is turning off the generated sync pulses during the vertical interval when real transmitted sync is present. (Remember that the video isn't scrambled during the vertical interval.) To do that, we have to count the lines of video as they're received and make sure that transmitted sync is processed for the first 26 lines of each frame. The starting point for the count is the vertical sync signal and, as you recall, we've already isolated the signal. The sync separator we built earlier produces a positive-going version of vertical sync. If we use the rising edge of that signal as the zero point for the counter, we have to count a number of lines to reach the point where the lines of video are carrying picture information and are therefore scrambled.

The two lines in the frame that mark the beginning and end of the transmitted horizontal sync are 260 and 27, respectively. We need a circuit that can count the received lines and let the rest of the descrambler know when to use received horizontal sync and when to use the artificial sync generated by the phase-locked loop. The zero point for the counter will be the rising edge of our vertical sync signal. Since that occurs at line 3, we have to decode a count of 24 and 257.

We can use a 4040 to do that job as well. This is the same sort of counter decoding we've done before in this project and others. When the counter reaches 24 we have to enable a gate that will send the phony horizontal sync pulses to the video amplifier at the circuit's input. When we get to a count of 257, the gate has to be disabled to let the real horizontal pulses through to resync the phase-locked loop circuit.

Decoding those two numbers is a pain in the neck since it involves watching nine counter lines. You can do that with a bunch of gates, but a better way is to use an EPROM. The choice is yours although, if you haven't had much experience in this sort of decoding, it's probably a good idea to work out the logic and build the decoder with gates. Otherwise an EPROM is the way to go. Assuming, of course, that you have programming capabilities.

When we get together next time, I'll give you the truth table for the EPROM and we'll finish off the descrambler. All that's left is a couple of flip-flops, a bit of work on the video section, and a way to detect the presence of normal or inverted video. Simple stuff! Ω

FET'S

continued from page 56

o handle higher currents. As najority-carrier devices that tore no charges, they can witch faster than bipolar ower transistors.

Figure 12 is a section view of n N-Channel, enhancement-node power MOSFET. Unlike s small-signal counterpart, he latest power MOSFET's are abricated with vertical rather han planar structures. They re made with the double-iffused (DMOS) process, and hey have conductive silicon olysilicon) gates. The gate of his device is isolated from the ource by a layer of insulating ilicon oxide.

When a voltage is applied be-ween the gate and source ter-minals, an electric field is set up ithin the MOSFET. This field lters the resistance between he drain and source terminals, nd it permits conventional cur-ent to flow in the drain in re-ponse to the applied drain ircuit voltage. There are also P-hannel, enhancement-mode ower MOSFET's in which con-entional current flows in the pposite direction of the N-hannel device. Figure 13 is the chematic symbol for a DMOS nhancement-mode, N-channel ower MOSFET.

Figure 14 is an cutaway view f a typical DMOS power OSFET. It is made up of many *ells* or transistor elements onnected in parallel. Each ource cell consists of a closed ectangular or hexagonal chan-el which separates a source re-ion from the substrate drain ody. The cells are formed in an ntegrated circuit process, and here might be more than a half million cells per square inch of substrate. All of the source cells re connected in parallel by a ontinouus deposition of alu-minum metalization, which orms the grid-like common ource terminal.

The DMOS power MOSFET ontains an inherent PN junc-ion diode, and its equivalent ircuit can be considered as a diode in parallel with the source-to-drain channel, as shown in the schematic symbol of Fig. 13.

International Rectifier (IR) makes DMOS power MOSFET's that have hexagonally shaped cells, so it calls its products HEXFET's. Motorola Semiconductor also offers DMOS power MOSFET's, but its devices have rectangular rather than hexagonal cells. Motorola named its power MOSFET's TMOS to call attention to the T-shaped current flow that occurs in the cells between the common drain and the channels to the multiple sources.

Power MOSFET's are widely specified for high-frequency switching power supplies (generally those that switch at frequencies above 100 kHz), AC and DC motor speed controls, high-frequency generators for induction heating, ultrasonic generators, audio amplifiers, and amplitude modulation transmitters.

The advantages to using power MOSFET's over power bipolar transistors include:

- Faster switching speeds and lower switching losses.
- Absence of the bipolar's second breakdown
- Wider safe operating area
- Higher input impedance
- High, if not higher, gain
- Faster rise and fall times
- Simple drive circuitry

The principal disadvantages of power MOSFET's are their higher cost and a higher static drain-to-source on-state resistance, which can cause unacceptable power losses in certain switching applications. However, the manufacturers have made progress in reducing those resistance values. DMOS geometry has largely replaced the V-groove or VMOS process that was widely used to fabricate power MOSFET's back in the 1970's.

Radio-frequency power MOSFET's are now available that will operate over the 2 to 200 MHz frequency range. The high power and high gain of these devices makes tham suitable as power amplifiers in solid-state transmitters for FM and TV broadcasting. Ω

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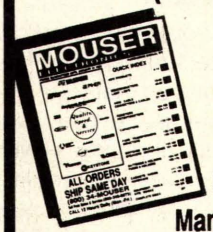

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COMPUTER CONNECTIONS

The Emerging PC

JEFF HOLTZMAN

1992 drew to a close with some of the most exciting developments in the PC industry in years. There is no single overarching product or technology, but lots of little bits and pieces that together point to the emergence of a new class of personal computers with unprecedented power, versatility, and connectivity. Core technologies include powerful and upgradeable CPU's, general-purpose digital signal processors (DSP's), rapid acceptance of local buses and corresponding decrease in the ISA/EISA/MCA bus wars. Other trends involve accelerated true-color graphics, motion video compression and decompression, drastically reduced power consumption, increased semiconductor and magnetic storage, full-featured operating systems, built-in local-area network connectivity, 100-MHz+ LAN speeds, and wireless cellular networking.

PC architecture

During the past year, the 486 has quickly surged ahead of the 386 as the platform of choice. Spurred on by competition from Cyrix, AMD, and others, Intel has released a wide variety of 486-based devices, with many more to come. Prime features of all include low power and performance enhancement through clock-doubling—and -tripling, as demonstrated by IBM recently—technology. The clock doublers have been well received, even though pricing continues to hover near that of full motherboard upgrades that provide better performance.

And speaking of Intel, you may think of the company primarily in terms of CPU's, but during the past few years, Intel has stuck its corporate thumbs in numerous pies—and has come out holding several juicy plums. Of course, there are the CPU's. There is also video-compression technology, exhibited first as the Digital Video Interactive (DVI) boards for digitizing and displaying full-motion video on desktop computers. Part of DVI is Real Time Video (RTV), which Intel has ported from the i750 video processor to the 386/486/Pentium architecture, and now calls Indeo. Indeo is one of the compression algorithms included as part of Microsoft's Video for Windows; Indeo is also being supported by Apple's QuickTime, and by IBM's recently announced Ultimotion. As discussed here in the preceding few months, software-only video is gimmicky, but an important first step in computer video.

Then there are network cards; Intel's cards are highly regarded, and are available for extremely competitive prices. Next come faxes and modems. Intel's SatisFAXion 400 is the highest-performing general-purpose modem and fax card combination on the market, although its bundled software leaves something to be desired. And let's not forget about PC integration chip sets, especially the upcoming Peripheral Component Interconnect (PCI) devices that will provide a standard local-bus architecture for 32- and 64-bit microprocessors. PCI-based systems should start appearing about the time you read this.

Of course, PCI is not the only kid on the block; a competing standard is the VL bus, named after the Video Electronics Standards Association's local bus. Both VL bus and PCI provide high-performance links between a CPU and its peripherals (such as network, video, and disk controller cards). In the words of one industry analyst, VL-bus seems to be better supported by expansion-card manufacturers, and PC by systems developers. Despi the lack of accepted standards, l cal-bus video is catching on. At la fall's Comdex, the computer indu try's leading trade show, numerou video-card manufacturers ar nounced VL-Bus products, inclu ing ATI, Cardinal, Genoa, Matro VideoLogic, and VidTech. Nonethe less, Intel's influence should not b underestimated. It will probably tak 18–24 months for VL bus or PCI t emerge as a clear victor; in th meantime, both will be well sup ported by many manufacturers One irony of all this is that the IS vs. EISA vs. MCA bus war initiate with IBM's April 1987 introduction o the PS/2 line has become moo The traditional expansion bus will b relegated to mouse, modem, an other low-speed devices.

The emergence of Windows (an to a lesser extent OS/2) has drive video card manufacturers to ur precedented levels of price/perfo mance in just a few short years Little more than two years ago, high speed, high-resolution, high-colo (24-bit) cards were available only o coprocessor-based boards, wit prices beginning around $1000. To day, you can get "accelerated" vid eo adapters that provide 80% of th performance for 20% of the price o the coprocessed boards.

High-resolution monitors hav also fallen in price, but not nearly a much as required. In addition screen sizes greater than 16 inche invariably mean bulky, heavy, power hungry devices. The monitor re mains the weakest overall compo nent of today's computer system.

One area of potential concern is semiconductor memory. The U.S Department of Commerce recently instituted import duties on memory chips from several Korean manufac

turers; street prices have already risen 25–30%. The DoC is expected to make a final ruling in early spring about whether those manufacturers are "dumping" chips below market value. If so, growth of Windows, OS/2, and corresponding applications software will likely slow. On the other hand, IBM and other manufacturers have started shipping 16-Mbit DRAM's on various systems. Clearly, the day of 16-, 64-, and 128-megabyte systems is not far off.

Digital-signal processing is poised to change dramatically the way PC's deal with analog data. Texas Instruments recently introduced a DSP chip and several corresponding boards that provide fax, modem, sound synthesis, speech-recognition, and data-compression capabilities. If this chip were made a standard part of every motherboard, it would eliminate the need for dedicated fax, modem, sound, and compression boards.

Pervasive networking

It won't be long before every desktop and portable PC, Macintosh, and workstation comes with built-in network capability. Chips & Technologies and Standard Microsystems have joined AMD, Artisoft, and National Semiconductor in the market for low-cost, single-IC Ethernet interfaces. These devices provide a complete network interface in a $20 package (in lots of 1000+ pieces). Zenith Data Systems was the first to include a built-in Ethernet port, but other manufacturers are following suit.

In the local-area networking arena, Microsoft released Windows for Workgroups (WfW), a version of Windows with built-in peer-to-peer networking. Although not as robust as market leader Lantastic, WfW has built-in scaled-down versions of Microsoft's widely regarded E-mail and group-scheduling applications. The main thing lacking is a DOS client (i.e., it is not possible to attach to a WfW server from a DOS-only machine). However, Microsoft will sell one separately, and may well bundle it with the forthcoming DOS 6.0, which will also include anti-virus, disk-compression, and robust backup utilities. That should further squeeze Symantec/Norton and Central Point Software, providers of popular utility programs. WfW will not likely displace large NetWare (or other brand) LAN's. Microsoft appears to be targeting first-time network users and corporate workgroups with traditional client-server systems (e.g. NetWare) that also need peer-to-peer services.

Wireless networking is on the verge of exploding. There was a burst of interest on this subject at Fall Comdex. For example, two leading computer companies (IBM and Apple) have teamed up with several cellular telecommunications providers (McCaw, Ram Mobile Data, Ardis—itself a joint venture between Motorola and IBM—and others) to support Cellular Digital Packet Data, a way of delivering digital data (e.g. E-mail) to one or more recipients anywhere, on demand, and in real time. IBM, Apple, Motorola, and a startup called Eo demonstrated various notebook computers, stylus-input devices, and personal digital assistants (PDA's) performing CDPD activities with attached cellular modems and cellular telephones.

Portables and printers

More manufacturers are supporting the PCMCIA (Personal Computer Memory Card Industry Association) standard. One vendor has gone so far as to call PCMCIA the ISA bus of the 90's. PCMCIA is not, however, without problems. The technology has gone through several fairly rapid evolutionary stages, PCMCIA 1 and PCMCIA 2, the latter being the current version. PCMCIA 1 was originally designed for memory expansion; but the idea of credit-card-size expansion devices quickly caught on and was expanded. IBM, for example, recently introduced several products called Credit Card Adapters that provide Token Ring and Ethernet connectivity, and 3270 terminal emulation. Other vendors also provide fax and modem adapters.

The technology has evolved more rapidly than the standards, so there is a potential for incompatibilities. To help avoid those problems, Intel developed an enhancement to PCMCIA 2, the Exchangeable Card Architecture (ExCA), which appears to be catching on. In addition to basic PCMCIA 2 compatibility, ExCA addresses several other issues, including the use of multiple cards in a system, and hot swapping (the ability to insert and remove cards with power on). Caveat emptor if you plan to buy new systems with PCMCIA expansion capabilities.

On the other hand, pen-based computing (as discussed here in the February 1992 issue), has taken off much slower than expected. Originally, the industry expected to see significant activity by the end of 1992, but now it looks as if little will happen before late 1993. However, as one manufacturer puts it, "The timing for our projections was off—not the projections themselves."

Hewlett-Packard has once again created a ground-breaking product: The LaserJet IV. It is a true 600-dots per inch laser printer, with street prices starting around $1300; for PostScript, add about $500. You don't have to look twice to see the difference between 300 and 600 DPI, especially when reproducing fine curves and gray-scaled photographs. Another innovation is bidirectional communications, which allows the printer to inform a host computer of such printer faults as paper out and paper jamming.

Compaq also broke into the high-resolution market last summer with an extremely competitive, large-format laser printer that accepts useful add-ins including a send/receive fax modem. That idea quickly spread to the retrofit market for older LaserJet II's and III's, which now have several choices for faxes that interface through font-cartridge slots. Microsoft will shortly introduce a II/III upgrade cartridge of its own. The company claims that this cartridge will print Windows graphics much quicker than with the use of either PostScript or PCL. It will also provide a voice interface that will, for example, inform the user aurally that paper is out.

On the workstation front, DEC recently released seven computers ranging from $10,000 workstations to $300,000 mainframes, all based on the long-awaited 64-bit Alpha microprocessor. DEC has also publicly

demonstrated Windows NT running on an EISA-based Alpha PC—that, incidentally, includes a PCI-based local bus. Sun and HP simultaneously announced competitive upgrades to their lines. Sun appears to be going after the high-end PC market, claiming much better AutoCAD performance than with a 50-MHz 486. Industry feeling is that HP provides the performance edge—but Sun still holds the largest market share, about 34%. IBM has been strangely silent about its well-received RS/6000 line throughout these recent scuffles.

Conclusions

Together, all these developments add up to a new era of power and convenience for personal-computer users. The day is not far off when you will be able to connect to a worldwide network from anywhere, at any time, and obtain any available information. The rate of approach to this goal has increased rapidly during the past year, and the trend is likely to continue. More next time.

Product watch

Figure 1 shows a screen shot of a ground-breaking new Windows database: Microsoft's Access. This is a product made to order for people whose needs exceed the capabilities of typical flat-file databases, but who don't enjoy writing code in dBASE (or whatever), and who, in any case, want a wholly Windows-based solution. To understand Access, imagine uniting a powerful, multilingual, multiuser database engine with a visual development environment like that in Visual Basic, giving it a good dose of object-oriented behavior, and topping it all off with extensive help and tutorial information suitable for occasional database developers.

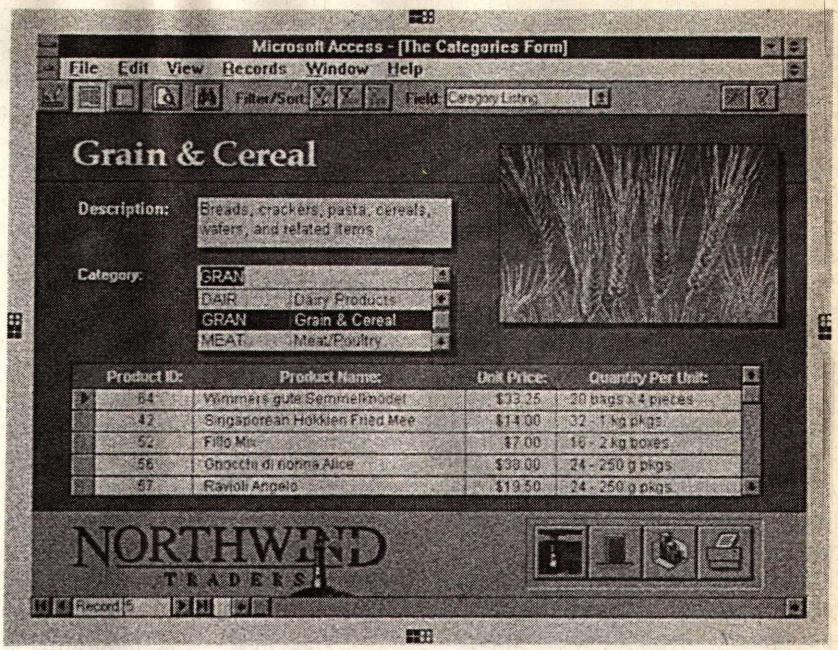

FIG. 1—MICROSOFT'S ACCESS HERALDS A NEW ERA IN DATABASE MANAGERS. This program provides power, ease of use, and ease of learning for Windows users. It spells trouble for Borland's dBASE and Paradox lines, both of which still have no Windows versions.

In addition to its own format, Access can read and write ASCII, Btrieve, dBASE, Excel, and Paradox files in their native formats. Access can also attach to SQL databases (at present, only Microsoft's SQL server, but Oracle support is scheduled soon). Access has extremely intuitive form-, report-, and query-building tools. For example, the form builder lets you draw fields, attach attributes (e.g. color and input validation criteria), and go.

Like Microsoft's other major Windows applications (Word and Excel), Access has just the right balance of power and ease of use. As with the other products, Access makes it easy to get started, and macros and a full development language called Access Basic provide lots of room for growth as your needs evolve. Access supports typical data types (character, date, numeric, logical), as well as binary objects including images, sound, and video.

Access is a fully relational product that allows one to create "virtual" tables, called Dynasets, that consist of records concatenated from other tables joined by common fields. Any updates to a Dynaset propagate back into the source tables from which the data came. Access also provides multiuser network access (including WfW support) and record-level locking. Initial pricing was set at about $100. If you can get a copy at that price, grab it. It's one of the best software deals around.

Home hardware hackers will want to check out Home Automation Laboratories, which publishes a catalog chock-full of information and product listings for devices that control lights and other electrical appliances remotely through special control panels or your PC. Simply reading the catalog can be an education in itself.

If you're looking for special laser printer paper or labels, check out the Paper Direct catalog. It lists numerous specialty items including foils that you can run through your laser printer to add color to presentations, prefolded brochure blanks that go through your laser printer and have business-card cutouts, and lots of other goodies. In both cases, tell 'em we sent you. Ω

Resources

- Microsoft Access ($495), Microsoft Corp., One Microsoft Way, Redmond, WA 98052. (800) 426-9400, (206) 882-8080.
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- Home Automation Laboratories, 5500 Highlands Parkway, Suite 450, Smyrna, GA 30082-5141. (800) YEL-4-HAL (catalogs), (800) HOME-LAB (orders), (404) 319-0600 (general).
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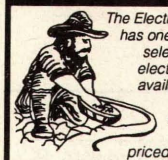

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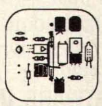

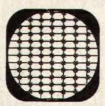

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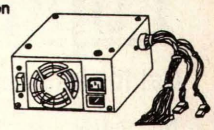
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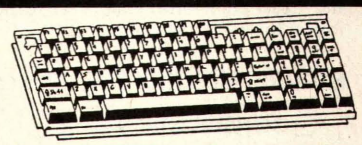
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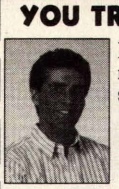

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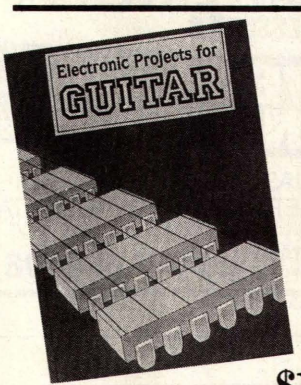

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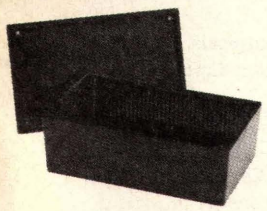

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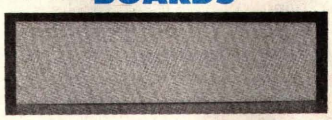

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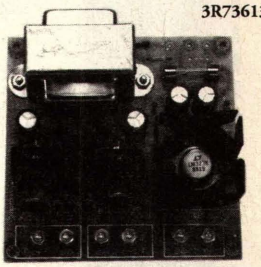

PartNo.	Product No.	Input Voltage (VAC)	Output Voltage (VDC)	Current (mA)	Dimensions (L x W x H inches)	Price
3R20360	JE200	120	+5	1000	3.5 x 5.0 x 2.0	$14.95
3R20626	JE215	120	+5 to +15 -5 to -15	750 to 175 750 to 175	3.5 x 5.0 x 2.0	19.95
3R73613	JE225	120	+5 fixed +3 to +12 - 3 to -12	1000 100 100	5.12 x 5.12 x 2.25	29.95

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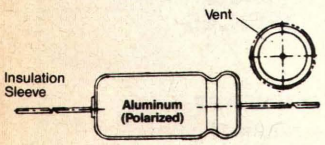
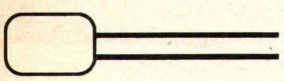
Capacitors



Axial Lead Electrolytic Capacitors

Part No.	Cap.	Volt.	Price
3R10866	1µF	50V	$.15
3R10997	22µF	50V	.29
3R10911	100µF	50V	.29
3R11121	470µF	50V	.49
3R11033	2200µF	16V	.69



Mylar Capacitors

Part No.	Cap.	Volt.	Price
3R26833	.001µF	100V	$.10
3R26884	.01µF	100V	.11
3R26956	.1µF	100V	.19
3R27001	1µF	100V	.69

Linear ICs*

Part No.	Product No.	1-9
3R33241	TL082CP	$.59
3R23579	LM317T	.65
3R23683	LM324N	.35
3R23771	LM336Z	1.09
3R23851	LM339N	.45
3R27422	NE555V	.29
3R24328	LM556N	.49
3R24467	LM723CN	.49
3R24539	LM741CN	.29
3R23131	LM1458N	.39
3R23157	LM1488N	.45
3R23181	LM1489N	.45
3R34278	ULN2003A	.69
3R24230	LM3914N	2.49
3R27385	NE5532	1.19
3R51262	7805T	.45
3R51334	7812T	.45

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IC Sockets

Part No.	Product No.	Description	Price
3R51570	8LP	8-pin low profile	$.10
3R37161	14LP	14-pin low profile	.11
3R37372	16LP	16-pin low profile	.12
3R39335	24LP	24-pin low profile	.19
3R40301	28LP	28-pin low profile	.22
3R41110	40LP	40-pin low profile	.28

LEDs

Part No.	Product No.	Description	Price
3R34761	XC556G	T1 3/4, (green)	$.16
3R34796	XC556R	T1 3/4, (red)	.12
3R34825	XC556Y	T1 3/4, (yellow)	.16

Transistors And Diodes

Part No.	Product No.	Description	Price
3R28628	PN2222	TO-92 case	$.12
3R28644	PN2907	TO-92 case	.12
3R35991	1N4004	DO-41 case	.10
3R38236	2N2222A	TO-18 case	.25
3R36126	1N4735	DO-41 case	.25
3R38359	2N3904	TO-92 case	.12
3R36290	1N751	DO-35 case	.15
3R38421	2N4401	TO-92 case	.15
3R36038	1N4148	DO-35 case	.07
3R38308	2N3055	TO-3 case	.69

3R26622 3R21936

Switches

Part No.	Product No.	Description	Price
3R21936	JMT123	SPDT, on-on (toggle)	$1.15
3R38842	206-8	SPST, 16-pin (DIP)	1.09
3R26622	MS102	SPST, momentary (push-button)	.39

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3R30867	330	1.95/C	2R30453	22K	1.95/C
3R29663	1.0K	1.95/C	2R29997	100K	1.95/C
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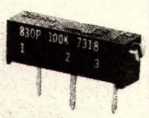

Part No.	Resistance Ω	Price
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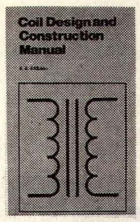

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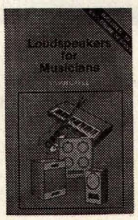

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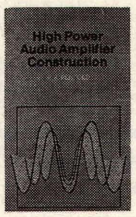

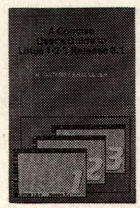

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